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THE DESIGN AND CONSTRUCTION OF A SENSITIVE LABORATORY BALANCE.

By Nevil Monroe Hopkins.

Probably no instrument of precision exists to-day in the laboratories of the world which has done more for the advancement of chemical and physical research than the sensitive lever balance. This historic instrument has been to laboratory expansion and attainment what the chronometer has been to astronomy, or the science of applied mathematics to the great engineering achievements. It is safe to assert that the fraudulent science of alchemy was remodeled into the true and beautiful science of chemistry chiefly through the influence wrought over the mind of man by the facts obtained in the close measurement of mass. It is the wish of the writer to present the important controlling elements embodied in the design of a correct balance, and give practical directions for making a universal instrument for fine weighings and delicate determinations of specific gravity. A balance for quantitative chemical analysis may be constructed upon the same principle, but with a shorter and lighter beam than that which is herein introduced. The vital element of all lever balances is, of course, the beam, the design of which demands careful consideration of the requirements to be satisfied. The beam of a correct laboratory balance should be absolutely rigid, and have its three knife edges in a single line, with the center of gravity of the beam an infinitesimal distance below the point of support, if great sensitiveness is desired.

The knife edges at either end of the beam must be precisely equidistant from the edge of the center supporting knife. The weight of the beam must be small, and so adjusted that it will remain in a horizontal position without the pans or suspending stirrups. All knife edges must be ground true, and, if made of steel, be tempered as hard as it is possible to temper, by means of mercury. In order to acquire the requisite stiffness with a small mass of metal, a truss is formed having a deep, but narrow section at the center. Let us observe the reason for making the beams as stiff as possible. To appreciate the motive, it is necessary to understand the effect of raising or lowering the center of gravity of the finished beam, including the knife edges and pointer. If we make a beam having its center of gravity above the supporting knife edge, it will not be possible to make it remain in equilibrium. If we so adjust matters that the center of gravity of the system coincides exactly with the point of support, the beam will remain in any position in which it is placed, indifferent and useless.

If, on the other hand, we bring the center of gravity a trifle below the point of support, the beam will rock from side to side and gradually come to rest in a horizontal position (provided the arms are of equal weight and length), with the center of gravity directly under the lower knife edge. Let us adjust matters with great care, bringing the center of gravity a small fraction of an inch below the point of support, and note the effect if we imagine the beam to bend slightly under a load in each pan. As the beam droops under the strain, the center of gravity, of course, changes, and our careful adjustment counts for nothing.

It is a very difficult matter to design a beam and predict beforehand the exact location of the center of gravity, and in all cases this is located after the completion of the beam, by adding a small weight either above or below the point of support, as the case may require. Embodied in the balance, which is presently described in detail, is a double pan of weights, which may be seen by referring to Fig. 1, which gives a fair idea of a balance built according to a system of the writer, in which the beam is built up, instead of being sawn out. These little weights are carried on screw threads, allowing of easy adjustment, making the balance as sensitive as any case may call for, or more stable for weighings of a rougher character, respectively. A correctly designed and successfully constructed balance, adjusted for great sensitiveness, will not only turn through a very perceptible arc, upon adding an infinitesimal weight to either pan, but will turn perceptibly upon adding the same microscopic mass, even when the pans are loaded to their full capacity.

The importance of a rigid beam is not easily overestimated, when it is pointed out that the above mentioned experiment constitutes the major test for fine balances. The second test consists in experimentally determining the relative positions of the knife edges. In no physical construction is it possible to place the knife edges for the pans mathematically equidistant from the center supporting "line," but, with great care, the distances may be very accurately laid off, although for the finest determinations this accuracy is not relied upon, and the body under examination is first placed in one pan, then in the other, and the geometric mean taken. A second method consists in placing the substance in one pan and accurately counterbalancing with fine emery, which is afterward counterbalanced with known weights instead of the unknown mass. The first steps in starting the construction of our balance consist in choosing the material for the beam.

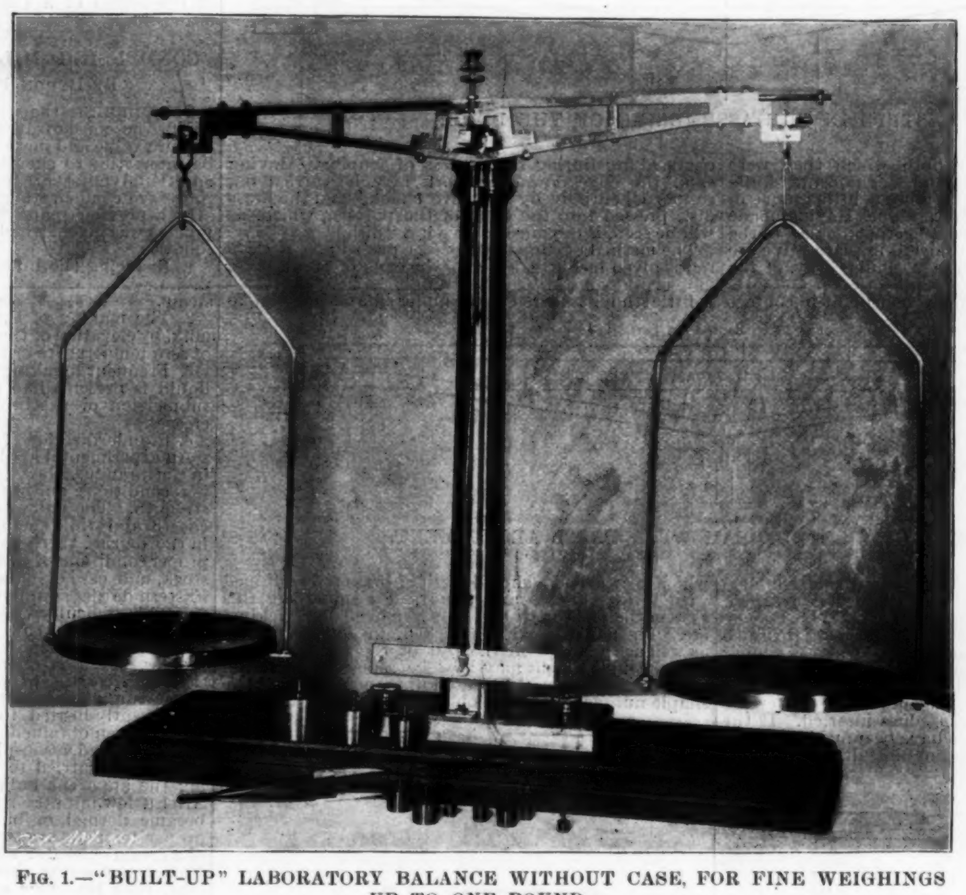


Fig. 1.—"BUILT-UP" LABORATORY BALANCE WITHOUT CASE, FOR FINE WEIGHINGS UP TO ONE POUND.

For a generally useful instrument, adapted for exact weighings, up to a pound in each pan, the material for the beam may consist of square brass rod, measuring 3-16 inch on a side. Brass rod may be had in lengths, drawn accurately to 3-16 inch on each face, and requires little truing up. The writer does not wish to limit the builder, however, to a balance of definite dimensions, and does not prescribe the measurements to be taken, but gives the construction in detail, which will serve for a large or small instrument.

For 3-16 inch brass rod, the total length of the beam should be about 14 inches, the straight top member being 12 inches. Having cut a length of the brass rod for the making of the upper edge of the beam, one end should be placed between the jaws of a vise, and the bar made perfectly straight by turning the free end by means of a wooden clamp. This straightening may, and may not, be necessary with a given lot of material, but it is expedient to "sight" along the sample in the vise in order to detect any twist. Having cut off and straightened the length for the top, a piece for the bottom or bent member must be procured.

It is safe to cut off a piece measuring about 14 inches in length for this rod, as the bending reduces its "reach." This piece, after careful straightening, in the manner described for the first piece, is laid off with a pair of dividers, and the middle point carefully marked. It is now evenly placed in a vise, in the manner indicated in Fig. 2, where it is securely held between the jaw, C, and the metal cylinder, D, which may consist of a short section of solid brass rod and the two blocks, B B, held in the lower jaw. The point of bisection of the rod should come directly under the cylindrical piece of brass. The handle of the vise is now turned, which bends the bar accurately and to any desired degree. For a 12 inch beam the distance, D, should be about 1 inch. This will form a truss, the depth of which allows ample room for the reception of the center knife edge and its supporting plane, and throws the center of gravity of the combination, when bolted together, at a point where it is easily adjusted by means of light screws as described. The ends, A A, must now receive attention, being bent down until their upper edges are in a straight line. The ends must be bent in the jaws of the vise, exercising care to avoid side efforts or strains.

The exact degree to which these ends are bent down is determined by trial with the straight top piece of the beam, as shown at A A, in Fig. 3. The superfluous length of rod is now sawn off with the hack saw, making the ends square and even with the top piece. These operations must be done accurately and neatly in order to insure an accurate beam. The next step consists in sawing out two "steps" from brass plate of the same thickness as the brass of the beam and filing to shape. Before cutting out, the pattern of the "steps" must be carefully drawn on the brass. In this figure, B and C represent two different types which may be used; both, as will be observed, have the same amount of "drop."

This question of "drop" is exceedingly important, for if they are too short, it will not be possible to place the three knife edges in a line. This will be made clear by referring to the "steps," C and D, which are seen in position, held under the pressure of a couple of iron clamps, the horizontal lines drawn across the illustration representing threads, which may be stretched to show the amount of space afforded for the center knife edge. The support for the center of the beam, and the metal for the reception of the center knife edge, is represented in outline at E, drawn upon the brass plate, F, also of the same thickness of the beam material.

In order to cut this to fit neatly into the beam, the angle of the bent rod should be marked on the brass piece while it is held in position against the beam pieces by means of a third clamp. This is cut out by means of the hack saw, and smoothed up in the vise by means of a fine flat file. With everything in good shape we are ready for the permanent mounting of the beam. The end pieces, C and D, are to be soldered in position in addition to small bolts which pass through the entire trio of bars. The best way to proceed is to "tin" the upper and under surface of the shank of the "steps" with a thin layer of solder, and again place in the vise for final and accurate adjustment. See that every edge is even, and clamp down firmly by means of the iron screws.

We can now hold the work in the flame of a Bunsen burner or alcohol lamp until the solder "flows" and unites the three pieces. This is, of course, done on both ends alike, and the surfaces are filed up and polished. The center piece need not be soldered until these ends have been finished and smoothed, as it is sufficiently distant from the ends to insure against having them melt if the heat is applied locally and judiciously. This is "tinned" in the same manner and placed in position, making the most careful measurements with a pair of dividers to insure its exact centering. If the worker is at all afraid of the ends heating up beyond a desirable point, they may be kept cool artificially or placed again in the clamps. We can now polish up the work a little and begin the work of screwing together for appearance and additional strength.

The proper distribution of bolts and screws is shown in Fig. 4, which represents the beam with the knife edges in place, and a trial adjustment for center of gravity upon the index pointer. To make the knife

edges, it is only necessary to procure a short strip of the best cast tool steel, and saw into little lengths of $\frac{1}{8}$ inch for the end knives, and one section of $\frac{3}{4}$ inch for the center knife. These little pieces are filed to shape, and the little "knives" tempered in mercury. The inclines forming each edge must be filed up equal in

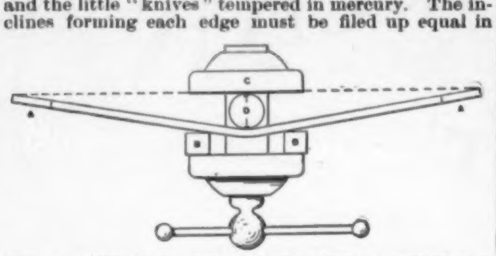


FIG. 2.—METHOD OF ACCURATELY BENDING LOWER PORTION OF BEAM TO SHAPE.

length, in other words the little wedges must have equal sides. The mercury treatment, which is herein given, makes the steel so hard it is impossible to "touch" it with a file. Heat up the little pieces separately in the flame of a Bunsen burner, or charcoal fire, to a bright cherry red, and plunge immediately into a pond of mercury.

It will be useless to attempt to scratch them with a file after this tempering, if the material used was the best

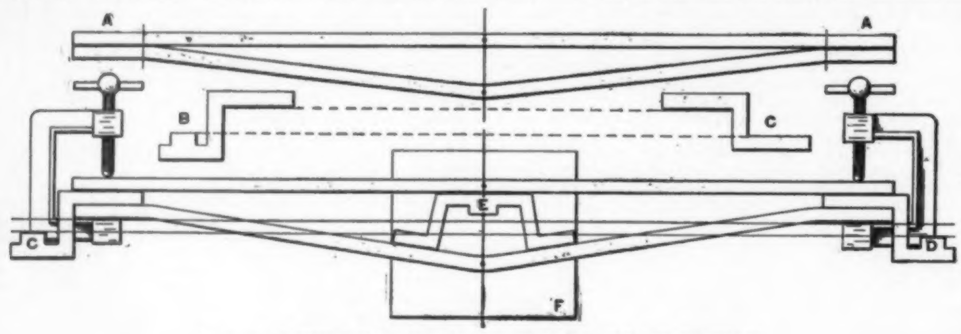


FIG. 3.—STEPS IN THE ASSEMBLING OF THE BEAM.

cast steel, and the mercury into which they were plunged weighed about a pound. The center knife edge is placed in position first, filing a little groove in the brass "bridge" for its reception. Having made sure that the axis of the edge is perpendicular to the beam, the knife is securely soldered in place. We are now ready for the insertion, in a similar way, of the end knives, but must make a couple of exact measurements before proceeding. With one point in contact

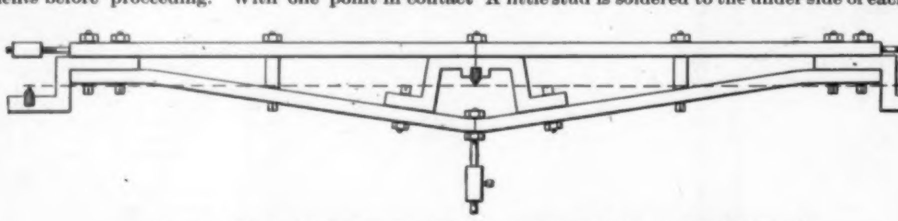


FIG. 4.—THE COMPLETED BEAM WITH TRIAL ADJUSTMENT.

with the edge of the center knife, our dividers are extended until the center of the "step" is reached, where a scratch is made upon the brass.

We now turn the instrument over, carrying the same limb, and point to the second "step," where a similar scratch is made, keeping the instrument free from all jar. Having made the two lines upon the brass of the "steps," similar grooves to the one in the center are filed down, and the end knife edges inserted. If the little inclines on these knives have been made equal in length, an operation which is not difficult, it will not be

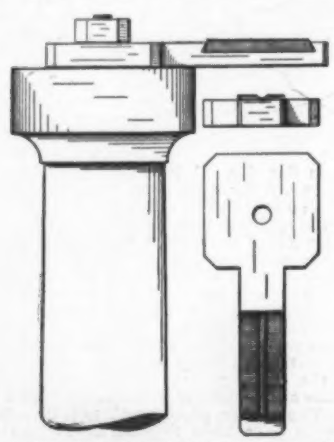


FIG. 5.—THE MAIN BEARING AND METHOD OF MOUNTING ON COLUMN.

possible to detect a variation in distance between the center and the end knife edges. These are now soldered permanently in position, and the superfluous solder removed with a fine file.

We must now turn up a column of solid brass 12 inches in height, having a graceful taper, ornamental top, and substantial base. Fig. 5 illustrates the top of a balance column, and gives the method of attaching the main supporting "plane." The system is too simple to require minute description, consisting merely of the brass support screwed to the top of the column. The plane upon which the center knife rests consists of a length of the tool steel let into the brass in the manner indicated. The steel rest has a slight half round groove cut in before tempering, by means of a fine rat tail file. The bottom of this column simply screws into a brass plate $\frac{1}{8}$ inch in thickness, which in turn is bolted to a base board, or the bottom of a case.

Fig. 5 illustrates the method of making the little "planes," for the stirrups and pans. Two little blocks of brass are filed out to receive pieces of hardened steel, provided with the same little semicircular groove as the main support. In order to hold these little steel blocks in place, it is only necessary to provide a couple of screws, as shown, which exert a pressure and keep the "planes" in position. A tiny groove is cut in the top of each holder for the reception of the little stirrups which are soldered on. These stirrups are filed from thin brass, the two being made simultaneously, and identical, by soldering together at the edges two pieces of brass, and working the two pieces as if they were one, which they substantially are, until heated, when they drop apart nicely, and are ready for filing and polishing.

The pans are now made by spinning two circular pieces of soft brass * over a wooden form as illustrated in Fig. 7. The diagram here is self-explanatory, to those at all familiar with the use of the lathe, and requires little comment. It is, of course, necessary to lubricate the end of the spinning tool with vaseline, or other thick oil, and anneal the brass once or twice in a charcoal fire during the process of shaping. Having spun the edge down, the work may be carried on, supported entirely by the "live chuck," and the brass disk pressed into the form of the pattern, which, as will be seen, is designed to give it a "dish."

The method of supporting these pans upon a cross rod is given in Fig. 8, showing the ends of stout brass wire or rod where it passes through the horizontal bar. A little stud is soldered to the under side of each pan, to which is attached a short length of brass rod equipped with screw threads and a nut. By employing this system the pans may be easily removed for packing, etc. The pans should be polished up and lacquered, as well as the brass on the rest of the balance. The experimental weight may now be replaced by one of permanent character, mounted upon a screw, and the simple nut, as illustrated on the top of the beam in

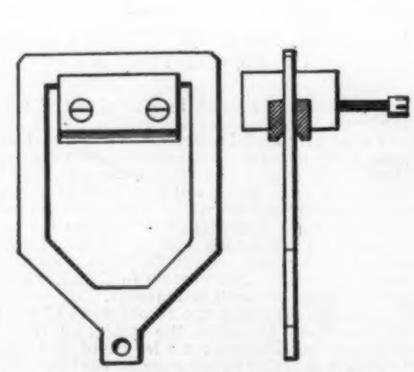


FIG. 6.—STIRRUPS AND PLANES.

Fig. 4, may be replaced by a second adjusting weight, if circumstances call for a rise in the center of gravity of the entire beam.

The pointer is made long and slender, and the scale attached in the manner shown in Fig. 1, which may be made of either brass or ivory, preferably the latter. Should the balance not take up a horizontal position with its pans complete, which must not be expected immediately, it can be brought up level by adding small scraps of brass on the underside of the lightest pan, etc. For fine adjustment, after the pans have been balanced, the beam should carry little end weights on screws, as given in Figs. 1 and 4. The making of a case is a comparatively simple matter, the design and construction of which hardly require description. It

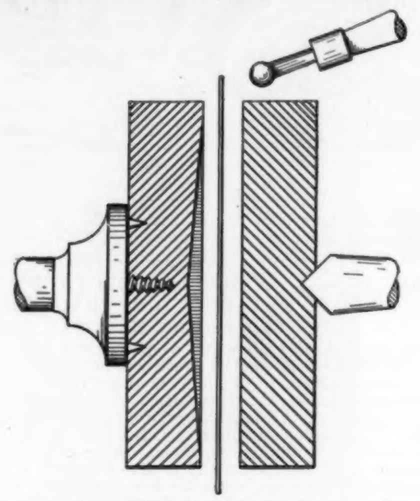


FIG. 7.—METHOD OF "SPINNING PANS" ON SPEED LATHE.

may be made from wood and glass, or metal and glass, according to the ideas of the reader. The balance must be carefully handled, and kept in a dry place. The photographic illustration illustrates a balance built upon this plan, which turns through a very perceptible arc when the pans are fully loaded upon the addition of one-fourth of a United States postage stamp to either side.

* Two varieties are to be had, soft brass and spinning brass.

CONDENSING MILK BY COLD PROCESS.

By BYRON F. MCINTYRE, Ph.G.

CONSIDERING the wide and extended territory in which the concentrated forms of milk are used, their dietetic value and methods of preparation cannot but be interesting to chemists and pharmacists; therefore additional notes are presented on the so-called cold process of condensation.

In a previous paper* a general description of the process was given, which may be briefly summarized as follows:

1. Reducing the bulk of the milk by conversions of the water of the milk into ice, instead of vapor or steam.

2. The making of the ice on the surface only of the milk, by elevation of the freezing pans in an atmosphere of zero temperature or thereabout.

3. Frequent breaking of the surface ice, so that fresh liquid is presented to a freezing effect, with gradual submersion of the broken ice as the bulk of ice increases.

4. Standardization of the product.

An experimental application of the process was made in Cattaraugus, New York, under favorable refrigerating conditions, and with milk of exceptional milk fat strength. The dairy product of this section had been cheese, and while there were strains of registered stock in the dairies, there had been little observance of the proper conditions of cleanliness of stables, feeding of the stock, and care of milk as found in the better class of Eastern dairies supplying milk for city delivery. Considerable difficulty was experienced in the selection of milk free from "cow odor." Milk with perceptible taint of animal odor is unfit for condensation by cold process, as these odors are intensified by condensation. To correct in part flavor defects in the milk, it was run into a vacuum pan, and the pan and contents gently heated to 80° F., a vacuum of 20 inches having been obtained. This treatment extracted animal gases and atmospheric air dissolved in the milk, which were carried to the surface in bubbles, increasing the apparent bulk of the milk about one-tenth. After a few minutes the foam broke up, and the milk became normal in bulk. The milk was then at the proper temperature for removal of milk fat by means of a cream separator which was set to run heavy cream. This heavy cream should assay not less than 50 per cent. milk fat. One object in separating the cream from the milk was to secure the extraction of dirt and foreign animal products, which were very much in evidence as a waste product adhering to the bowl of the separator. From the separator the fat-free milk was run over a bank of horizontal copper pipes through which ice water was circulated, reducing the temperature of the milk from 80° F. to 35° F. At this point it should be noted that milk reduced by heat

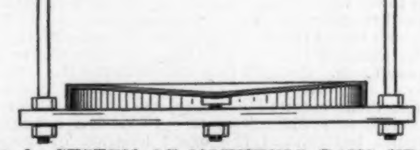


FIG. 8.—SYSTEM OF MOUNTING PANS UPON SUSPENDED BARS.

under vacuum conditions in the proportion of four parts of milk to one part of condensed milk will have a viscosity somewhat proportionate to the heat used in the process. In other words, heating thickens the albuminoids of the milk very much as egg albumen is thickened by heating.

In the cold process of condensing there is no thicken-

* The Alumni Journal, July, 1895.

ing or chemical change in the albuminoids, the density varying proportionately to the water content, so that four parts of milk condensed by cold process does not have the density or the quality of thickness as seen in commercial brands of unsweetened condensed milk. A condensation of 5½ gallons to 1 gallon is required to produce a product with the desired consistence or thickness, which is an increase of over one-third in the fat-free milk solids as compared with a standard of four to one. Economically considered this is unobjectionable, as the skim or fat-free milk has but little cash value, and the preparation has increased nutritive value in its nitrogenous constituents.

To determine the reducing ratio of this skim milk, 100 gallons (the quantity of milk used in a number of experiments) was divided by 5½, giving a final proposed product of about 18¼ gallons, which must include the cream admixture made at the finish of the process. The proportion of fat in this finished product should be $14\frac{4}{10}$ per cent., which has its equivalent in about 5¼ gallons of the heavy cream. Deducting this volume of heavy cream from the calculated volume of finished product, we have about 13 gallons as the standard to which the 100 gallons of skim milk is to be condensed by the freezing process. In other words, 87 gallons of water in the milk are formed into ice, leaving an unfrozen balance of 13 gallons of very thick milk, which represents in milk sugar, casein, and inorganic salts fully 9 gallons of solids. The fat equivalent represented by the 5¼ gallons of heavy cream is adjusted in the final product to represent in a dilution with water three parts, and condensed milk one part, a proportion of $3\frac{6}{10}$ per cent. of milk fat, which is the normal proportion in an average good milk.

The freezing closets having been properly refrigerated, the previously cooled milk, measuring 100 gallons, was put in the pan, the closet closed, and in due time the stirring apparatus was put in motion. After nine hours the whole bulk of milk was converted into a magma of ice crystals and milk sufficiently thick to form into hummocks. When run in the centrifugal, the thick milk measured about 50 gallons. An average sample of the snowlike ice, when melted and evaporated to dryness, gave two-tenths per cent. of residue. The 50 gallons of thick milk was returned to the freezing closet, and in six and one-half hours it was a dense crystal mass, which, after centrifugal treatment, measured about 25 gallons. The ice contained seventy-five one-hundredths per cent. of solids. A third freeze of four and one-half hours and centrifugal extractions reduced the bulk of the milk to about 13 gallons. The ice from this last freeze assayed one and two-tenths per cent. of solids. The total time both for freezing and extracting was about twenty hours with one freezing closet; but this time with two closets could have been reduced from one-third to one-half. It will be noticed that the percentage of solids in the ice increases slightly as the milk becomes concentrated, due to thick milk adhering to the ice crystals. This tendency is overcome largely by increasing the speed of the centrifugal, particularly on the last freeze.

A final step in the process was the admixture of the heavy cream in proper proportions with the concentrated fat-free milk. This final product or condensed milk is a fair representative of milk minus the bulk of its water. It is free from cooked flavors, it has a milk aroma which is true to the milk from which it is prepared, and it mixes easily with water, forming milk from which cream will separate as from untreated milk.

The specific gravity is about 1·16, the color is a creamy white, and the consistence is smooth, the milk pouring slowly. In taste it is bland and creamy, with a very pronounced sweet taste, which is strictly normal, as will be found by diluting with water to original proportions.

In keeping properties the new form of condensed milk is superior to whole milk, and the freezing temperature at which the milk is held is destructive of some forms of germ life common to milk, and the natural life of the preparation is prolonged by this partial sterilization.

A comparative statement of the use of unsweetened condensed milk, cream, and whole milk would be very instructive and valuable, but after careful inquiries it was found that accurate data could not be obtained, as unsweetened condensed milk is classified and shipped into New York city as cream, and vice versa.

The recorded figures* show that cream is preferred by the public, and the judgment of experts is to the effect that there is a diminishing demand for condensed milk, which possibly can be attributed to cooked flavors, lack of taste, and non-adaptability for cooking purposes or dilution to normal milk.

It is impracticable to condense liquids, except purely alcoholic, by solid formation of ice as in ice manufacture, because the dissolved solids are largely frozen in with the ice.

Liquids containing very soluble principles, as nutritive peptones and albuminoids, or solutions having odors and flavors, and liquids with very minute proportions of active constituents, are special directions in which the process can be used.

To illustrate, peptones, the product of digestive ferments on albuminoids, are reduced in bulk, and fresh meat juice can be condensed to a sirupy consistence without change in the extractives or soluble albuminoids of the meat juice.

Juices of fruits and aqueous extractions from coffee are concentrated without the slightest impairment of the quality of the flavors, and with proportionate concentration of flavor.

The aqueous extraction from malt can be condensed with but slight loss of active diastase in the conversion of starch, the diastase being inactive at freezing temperatures. A solution representing twice its bulk of malt, and containing about 35 per cent. of maltose, sugar, and extractive, was found to have a diastatic strength equal to the conversion of four times its weight of starch.—Journal of Pharmacology.

* The Milk Reporter, January, 1897.

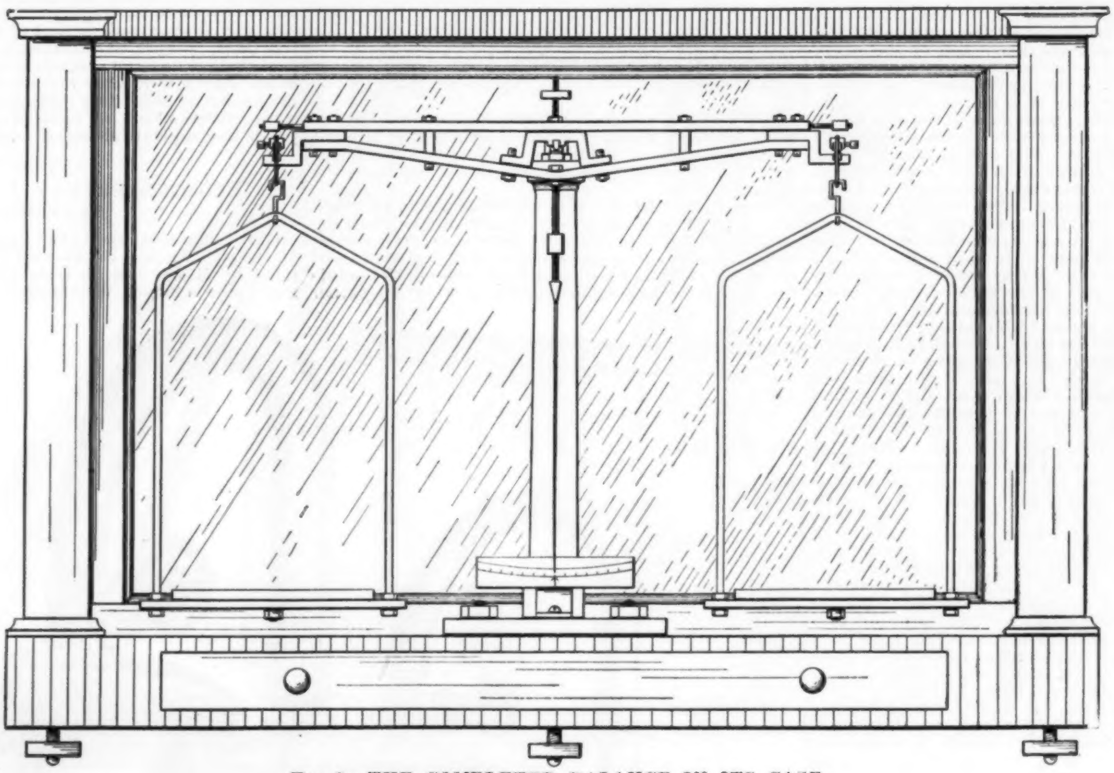


Fig. 9.—THE COMPLETED BALANCE IN ITS CASE.

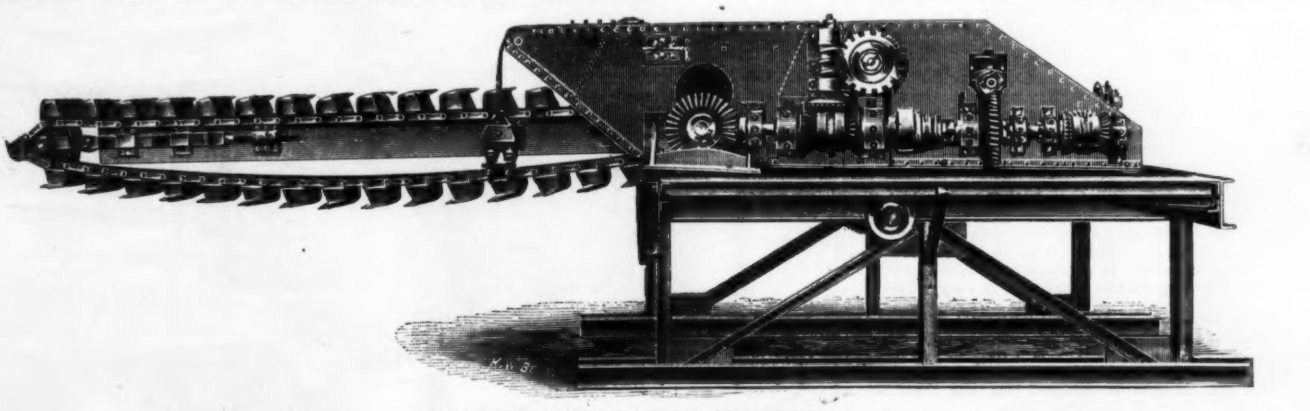
TUNNEL EXCAVATING MACHINE.

Considering the large amount of iron tunnels driven by shields in the London clay during the last few years, it is at first view surprising that no invention suitable for excavating in the shield has been brought forward. The machine we now illustrate is the first really successful attempt, and has been put down by Messrs. Walter Scott & Company on their Central London Railway contract. The machine was constructed to the designs of Messrs. Scott's agents on their Central London Railway contracts by Mr. Thomas Thomson.

The problem of constructing a machine which will get the earth from the interior of the shield and deliver it into wagons is more complex than would primarily appear; and before describing the machine itself it may be profitable to deal with the conditions that had to be met. One or two machines have been made on the principle of the circular heading with rotary cutters, but although such machines work well in rock or earth of equal hardness throughout, they will not work in clay with interspersed bowlders, such as the London beds. In addition to this, the blocking up of the face by machinery, forming an obstacle to the erection of the iron segments, and the difficulty of keeping the shield in alinement have proved serious difficulties.

The following conditions have been laid down as necessary in a machine to compete successfully with hand labor. It must be able to excavate without damage to itself in a face of hard clay, interspersed with septaria, in beds, and with occasional bowlders up to 4 feet in diameter. It must deliver the earth at a sufficient height to drop into wagons. It must not form an impediment to the other operations of erecting the iron and grouting; and it must be so designed that in the event of a breakdown in the machine itself, or of rock, or water-bearing strata, being met with in the face, hand work may be resumed at once. It must be so constructed that the direction of the shield can be controlled, and that the lines and levels of the actual face can be conveniently checked.

The ingenious machine we now describe has been built to fulfill these conditions, and in actual work has, we are told, proved thoroughly satisfactory to the contractors. It consists of an under-carriage with wheels, running on rails set to a gage of 6 feet 3 inches. This carriage is "Goliath shaped," with an opening 5 feet 8 inches in height, and of sufficient width to allow the



TUNNEL EXCAVATING MACHINE.

usual 2-foot gage earth wagons and iron bogies to pass clear underneath. The top of this under-carriage is strongly braced, and has fixed to it a short king post on which the top carriage or swing frame revolves. The top carriage has sides of plate iron, cross connected by bracing and by a central casting which revolves on the king post. Attached to the front of the top carriage is the actual excavating arrangement, consisting of a dredging bucket ladder 17 feet in length. This bucket ladder is held at a distance of about 6 feet from the tumbler by two chains passing to a winding drum in the upper carriage. The machine is driven electrically by a 100-ampere motor at 200 volts; current being supplied from the pit head by a 20-horse engine and 100-ampere, 200-volt dynamo. The motor is mounted on the back end of the machine, and by a 2-thread worm and wormwheel drives a shaft placed parallel to the top carriage. From this shaft the sluing gear and raising and lowering gear are taken, and on the end of the shaft a bevel pinion drives a bevel wheel which is keyed to the shaft of the driving tumbler.

The sluing gear consists of a pair of friction cones and bevel wheels driving, through a worm and wormwheel, a chain pulley, over which chains pass to the sides of the under frame. The raising and lowering gear consists also of a pair of friction cones driving, through a worm and wormwheel, the barrel on which the lifting chains are coiled. The traveling gear is worked from a pulley, on the opposite end of the motor, and belted to a pulley on a shaft placed over the king post. From this by a pair of friction cones a shaft, led down the king post, drives by a worm two barrels placed one on either side of the under-frame. From these barrels a wire rope is led fore and aft of the machine and anchored to the cast iron sides of the tunnel. As the dredger buckets are run at a much higher speed than is usual with large dredgers, careful attention had to be given to the feed. In each of the traveling motions, by the use of the worm gear, the motion is definite, and without the use of a brake the cutting end of the ladder would remain exactly in the position in which it has been left. The levers and wheels for working the motions are all brought together within easy reach of the driver, who stands on a small platform at the left hand side of the machine. The resistance switch and reversing switch are at the same point.

The bucket ladder is fitted with an extension screw arrangement for tightening up the bucket chain. The buckets are more of the nature of scrapers than buckets proper, having a bottom and back only. On the back are fitted four or five teeth alternately, these being of wrought iron, chisel pointed, and dropped into recesses cast in the back of the buckets. Cast steel buckets were first supplied with the machine, but one or two having been broken, they were replaced by those of gun metal, which has given better results.

In operation the machine is traveled up to the face and excavates all that can be reached for a distance of 18 inches to 2 feet in front of the shield. The machine is then run back 10 feet or 12 feet clear of the face and the shield pumped forward, the cutting edge bringing down the remaining portion of the earth. No difficulty has ever been met with in cutting down this part of the face, and, of course, there is a material engineering advantage in getting a clean cut and insuring that no cavities are left outside the shield. The face being now clear, the iron lining is erected and bolted up, and the excavator brought forward for a fresh cut. The usual small bowlders are taken out by the machine without difficulty. When large bowlders occur, the earth is cleared out all round by the machine and the bowlder got out by hand.

A fuse is inserted in the lead to the motor, so that in the event of too heavy a feed being given, no damage will result to the gear. So far no breakdowns have taken place with the exception of the breakage of some buckets, and the excavator has given great satisfaction in work. Being an experiment, it was not built as large or heavy as could be employed, and a greater saving would result by the use of a larger machine. As it is, the saving over hand labor is very considerable; the average advance is three 20-inch rings per shift of 10 hours, the number of men at the face, including driver, being eight.

The engines, pumps, and electrical machinery above described, including the excavators, have been supplied to Messrs. Walter Scott & Company, by Messrs. E. Scott & Mountain, of Newcastle.—Engineering.

HOW TO CARRY A CAMERA ON A BICYCLE.

By J. U.

The positions in which a camera may be carried by a cyclist may roughly be divided into two classes: (1) on the machine itself, (2) on the rider's body.

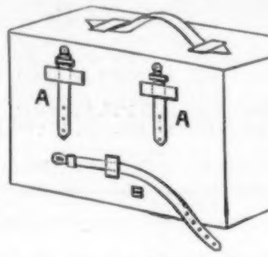
Dealing with the second of these first. By far the safest position in which to carry the camera is on the cyclist's back, for jolts and vibration caused by the machine running over uneven ground are only transmitted to the camera after passing through the rider's body. If it is decided to carry the camera in this manner, the best plan is to place it in a stiff case, and to sling it over the shoulders like a pair of race glasses, letting the camera rest just above the hip. This plan renders mounting and dismounting somewhat difficult; but, in the case of a long ride, it will be found more comfortable than carrying it knapsack fashion, as in the latter case the drag on the shoulders is very wearisome.

Some cyclists, who use a folding quarter-plate camera or one of smaller size, are accustomed to carry it in a side pocket. To such a plan there is a very grave objection, for, in case of a fall occasioned by side slip, not only will the camera be broken, but the rider is likely to be badly injured about the hips.

Proceeding now to the positions in which the camera can be attached to the bicycle, we find that there are three likely places, namely, on the handle bar, in the center of the frame, and at the back, beneath the rider.

When the camera is light in weight there is scarcely a better plan than to attach it to front of the machine by a spring carrier, such as the Frena, Sun, or that recently placed on the market by Mr. Murray, of Belfast. The two latter interfere with the position of the lamp, which must be attached by a separate clip either lower down the head or to the front forks. There is a slight objection to this class of carrier, because the steering is rendered rather more complicated. At first the feeling is rather strange, but after a little practice one becomes accustomed to the new order of things.

With the narrow tread of modern machines, it is next to impossible to carry a camera comfortably in the dia-



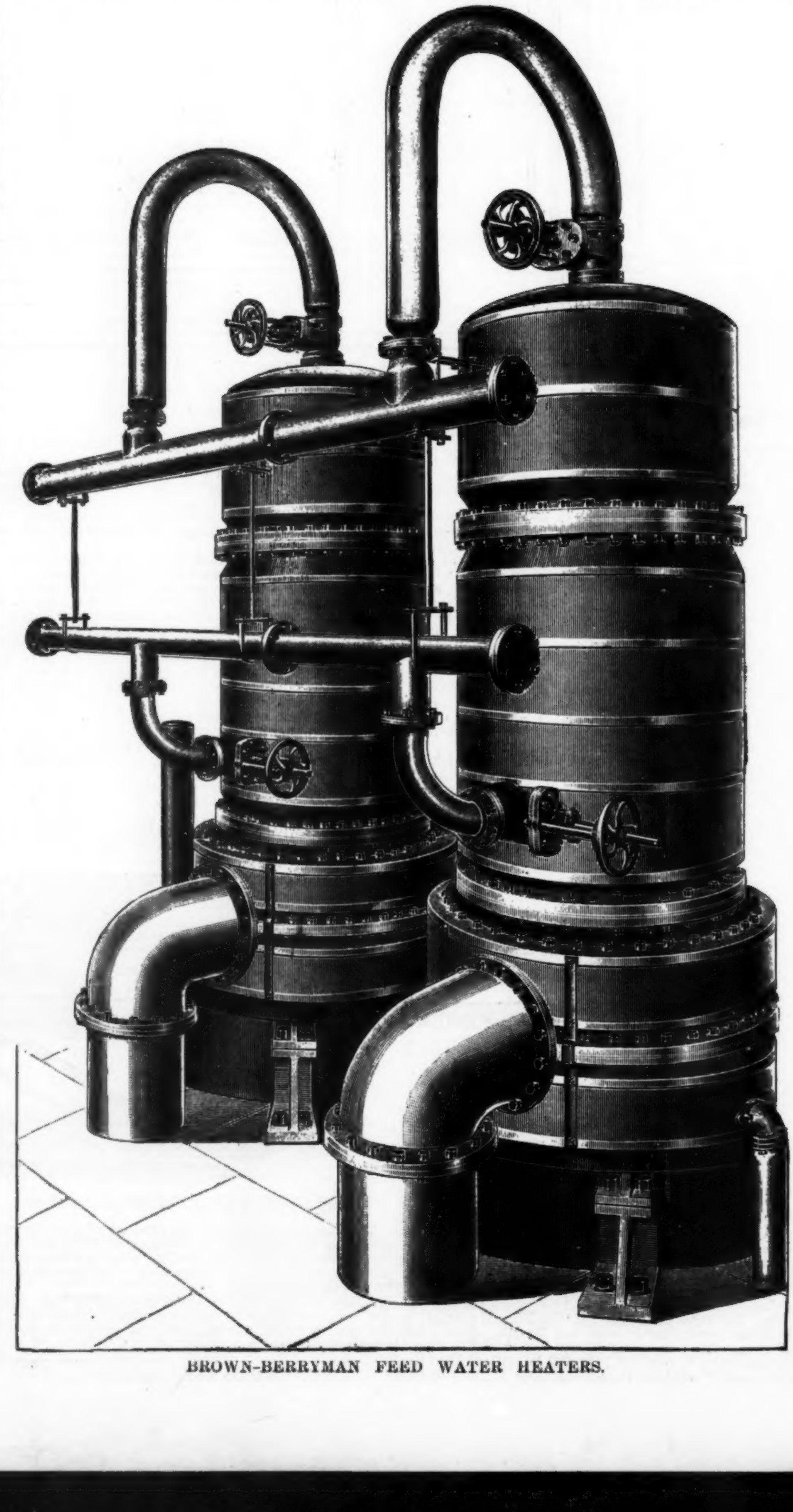
mond frame, on account of the chafing produced at the knees of one's knickers. This position can only be used for cameras of small size, or those which collapse until they become very narrow, as, for example, the folding Kodaks.

Then coming to the back of the machine, an excellent place where a camera can be carried is beneath the saddle. The camera case will require three extra straps, arranged as in the rough sketch. *A* and *A* are placed the same distance apart as are the holes in the saddle from which the toolbag usually hangs, while *B* is rather longer, and fastened near the bottom of the case. The bag is attached by buckling *A* and *A* through the saddle holes, and then fastening *B* tightly round the compression stays. If the camera be somewhat bulky, say half plate size, then a carrier such as is made by Turner, of Manchester, is to be recommended. This carrier consists of a wire platform, which is attached to the back stays just above the mudguard. It is made in various sizes and shapes, and the stronger patterns will more than support any weight which the cycling photographer is likely to put upon them.

Finally, a word on packing the bag. In whatever position it is decided to carry it, the bag should be packed tightly, in order to prevent scratches and knocks. The camera should be wrapped up in the focusing cloth, while the double backs are best carried in green baize bags, and the lens, the most delicate and most expensive part of the outfit, is safest in the breast pocket of the rider's coat. In the case of those magazine hand cameras in which the plate drops down into a well after exposure, some clamping arrangement is absolutely necessary, otherwise the constant vibration will so grind away the edges of the plates that a plentiful crop of pinholes will be reaped.

BROWN-BERRYMAN FEED WATER HEATERS.

Our illustration shows two large feed water heaters of the well known Brown-Berryman type lately supplied by Messrs. Joseph Wright & Company, Tipton, and Victoria Street, Westminster, to the Metropolitan



BROWN-BERRYMAN FEED WATER HEATERS.

Electric Light Company, for its Manchester Square station. Each heater is capable of heating 6,000 gallons of water per hour to 212° by means of the exhaust steam from non-condensing engines, which passes through a cluster of brass tubes which are bent into a ∩ shape at the top, the bottom ends being bent outward and fixed in the circular casting at the bottom of the heater. This casting is surrounded by a belt, which forms the chamber into which the steam is admitted at one side, and from which, after passing through the tubes, it leaves on the other side. The water to be heated surrounds the tubes in the body and casing of the heater, and being pumped in at the lower end and forced through and out at the top, it follows that the pressure in the water casing is the same as in the boilers; and in this particular case it is 200 pounds to the square inch. The effect of heating the water to 200° Fah. under pressure is that the carbonates of lime, etc., in the water, together with the dirt and organic matter held in suspension, all fall into the bottom chamber of the heater, quite clear of the tubes, and upon the bottom is a lid or cover which can be removed without interfering with any of the pipes or connections, and giving free access to the inside, and complete facility for cleaning out without raising the casing. The cover of the steam chamber can also be lifted so as to allow of the ends of all the tubes being examined.—Engineer.

FIG. 1.

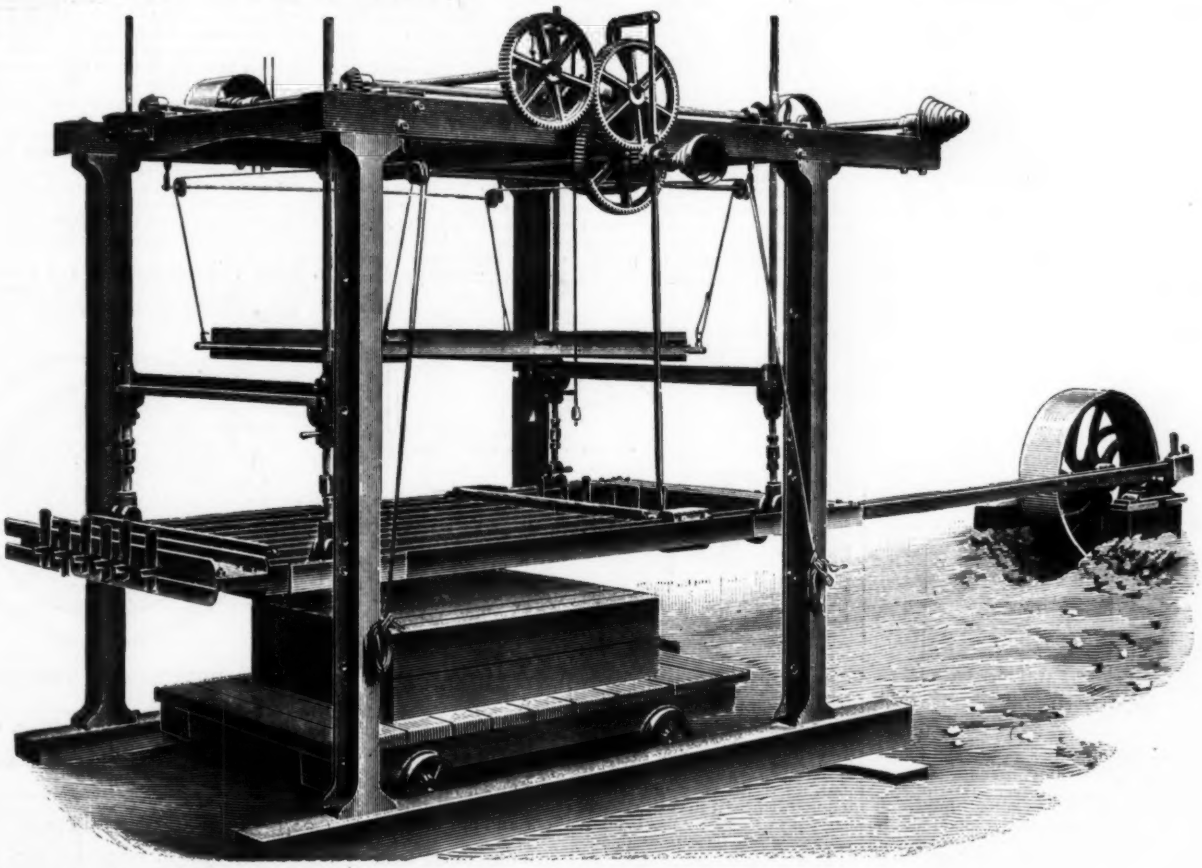


FIG. 2.

STONE SAWING MACHINES AT THE BIRMINGHAM SHOW.

STONE SAWING MACHINERY.

WE illustrate herewith two stone sawing machines exhibited at the recent Birmingham Show of the Royal Agricultural Society, of England. The upper engraving shows a rip cutting machine and the lower a direct driven frame cutting machine. They are both manufactured by Messrs. Rushworth Brothers, of Colne, Lancashire. The rip cutting machine will deal with stone, marble, or granite in blocks up to 9 feet wide and 2 feet 6 inches deep. It is fitted with a steam engine, which drives by a belt on to a countershaft. On this shaft is a crank, which is coupled by a connecting rod to the saw frame. As the sawing proceeds this frame is gradually lowered by screws operated by gearing at the upper part of the structure. This gear is driven by a belt from the crankshaft, and there are cone pulleys by which the rate of feed can be adjusted.

The frame cutting machine will deal with blocks 10 feet by 5 feet wide by 6 feet deep. The saw frame shown at Birmingham was driven direct by a connecting rod from the tail rod of the engine, which had a 9-inch cylinder. The piston rod of the engine drove a crankshaft in the usual way, for operating the slide valve, etc. This machine, also, was fitted with auto-

matic feed and reversing motion. The saws were soft steel blades, fed with crushed chilled shot and water, as a cutting agent. The machine illustrated is driven by a belt.—Engineering.

SOMETHING ABOUT BRASS FURNACES.*

WHILE there has been very little change in the methods employed in brass foundries for a number of years, there are comparatively few machinists who are at all acquainted with this branch of the trade, and a little information in this line may be of interest and value to some of them.

As with iron castings, there is green sand and dry sand work, the latter moulds being baked either in ovens, around stoves or by placing heavy hot plates over them. Sections of moulds which are of small size and liable to be washed out of place by the inflowing metal are often baked by placing hot plates or even coals over them, after they have been made ready to clamp for pouring. The moulding, ramming, and venting of moulds will not be discussed, as it is similar to any moulding, the variations being due to the difference in metals being handled.

The furnaces in many foundries are crude affairs, and can be called, without much exaggeration, a bricked-up hole, a few old pieces of iron for grate bars and a cover. The question of convenience is too often overlooked and the work of the foundry helper is made much harder than it should be; so there is little wonder that boys are averse to beginning life in a brass foundry.

The question of economy, either of fuel or labor in attending to the fire, is rarely considered, and brass furnaces are much the same as they were twenty years ago. Fig. 1 shows a foundry furnace of the usual type, which was built in 1890, and which does not differ materially from furnaces of much earlier date. There are six furnaces in this group or bank, each about 24 inches square (outside measurement), and consisting of cast iron bodies or plates bolted together. The furnace is square both inside and out, the lining being of ordinary firebrick about 4 inches thick. This leaves an opening of 16 inches for the pot or crucible, which allows about 2 inches on a side around a 175 pound pot. The core oven is adjoining it and is heated by the escaping gases from the furnaces, as will be seen from the section drawing in Fig. 3. While the sketches are not drawn to scale, they represent the proportions fairly well. The floor plates are perforated to allow any metal or dirt to drop through into ash pit, and in this case the outer ends are supported by pedestals made of about six inches of 2-inch pipe with a flange screwed on each end; these are not shown in sketch. The ash pit is about 3 feet below floor level and probably 4 feet wide, giving room for a boy to work, cleaning the fires and getting out ashes. The original plan included the use of an old chimney as an ash chute, and was gratefully used by the boy in charge of the ash department, until it filled up, never to be opened again, save by the use of dynamite or something equally forcible. Then the chute was abandoned and the ashes thrown up to the floor and carted down on the elevator by the still grateful boy—grateful because he didn't have to carry them down stairs. This is one of the joyous phases of the "boy's" life in the brass foundry, as it is usually conducted.

The grates consist of ¾-inch iron bars, pushed through holes in the brick work, with a hook or eye on the outer end, or nothing at all, as the case may be. The sketch shows an eye on end for bar, just for appearance sake. The hook or eye helps in pulling out to dump the fire. The coal consumption varies with different conditions, draught, etc., and it seems strange that so few foundries make any provision for forced draught. Not that it is necessarily more economical at all times, but there are times when the natural draught is below its normal intensity, and time as well as fuel could probably be saved by the use of a blower. There is probably a certain rate of combustion at which each furnace will give best results, and if a small blower were at hand to be used when needed, it would be possible to maintain the economical rate of combustion at all times.

This subject is very little thought of, probably because the majority of brass foundries are small affairs, not running over three or four furnaces and about the same number of moulders, so that the total fuel cost does not assume very large proportions; still there is room for vast improvement in this department, and it should be looked into by the economical manager.

The fuel consumption in the furnace shown was given me as 2,000 pounds for five days, to each three furnaces, or 400 pounds melted with 133 pounds of coal. The cost of coal is small in pounds per day, or 133 + per furnace, per day. These run two heats a day, melting on an average about 160 pounds per heat in each furnace, or 320 pounds of metal. This comparison with the cost of metal melted has been neglected entirely too long. Leaving this back-breaking furnace, for the cleaning out of the ashes and the lifting of pots with 160 to 180 pounds of metal out of a hot furnace by hand (with tongs of course) is hard work, we can consider a marked advance in the foundry of H. Belfield & Company, Philadelphia, Pa. (Fig. 2), which, as well as the whole plant, is in charge of Mr. Alfred Belfield.

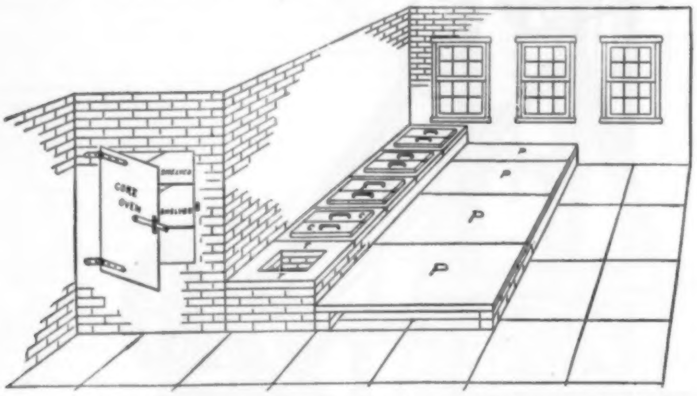


FIG. 1.—REGULATION BRASS FURNACE—SQUARE FURNACES.

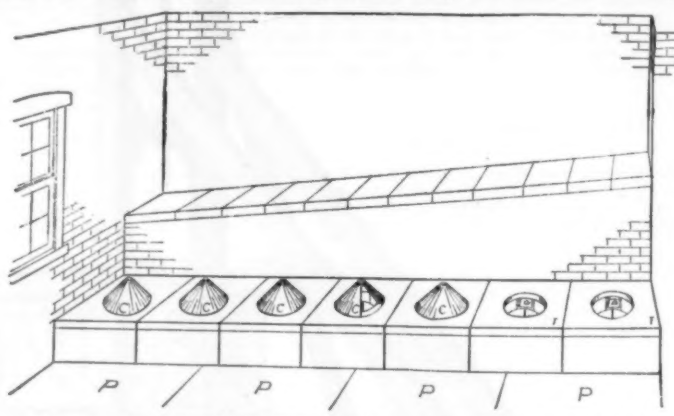


FIG. 2.—AN IMPROVEMENT ON FIG. 1—ROUND FURNACES.

This was not completed at the time of my visit, but enough was in place to indicate the improvement which has been made. The whole bank is to include eighteen furnaces, eight of which were already in place. Fig. 3 gives a general idea of the arrangement of these furnaces across the end of the foundry away from the moulders, who can keep comparatively cool; quite a change from the ordinary foundry, in which this receives little or no attention. The furnaces connect with the flue behind, which gradually increases in capacity toward the chimney to take care of increased volume of gases from the additional furnaces. This flue is closed at the top with large brick slabs which can be readily removed in case it is necessary to clear out the flue for any reason. In fact, everything about this foundry has been designed with a view to easy and quick repair when necessary.

The furnaces themselves are seen in Fig. 4, and consist of iron or steel shells 26 inches in diameter by 30 inches long. These are riveted with a butted seam, as shown, and a notch or opening left, to which is bolted a cast iron funnel or nozzle, which leads into the smoke flue. These are lined with fire brick "three pieces to a circle," as shown in the figure, and as they are three deep, there are but nine bricks to a furnace, making it an easy matter to renew any layer, or the whole furnace if necessary. These bricks are regularly carried in stock by fire brick makers and are not special, as might be supposed.

There is a cast iron base ring which rests on the foundation and on which the dumping grate and its ring are placed, the furnace shell resting on the outer grate ring. The grate is somewhat different from the miscellaneous collection of bars shown in the other furnace, being cast with trunnions for dumping and a catch in front not shown, but this probably cost no more than the bars first shown, and is decidedly more convenient.

The top or cover plate is also shown in the figure, being simply held to the bottom plate by four bolts, then the front bricked in to prevent radiation of heat, both for economy and comfort of man or boy cleaning out the ash pit. The ashes are here shoveled into a metal chute (not an unused chimney), and there is no difficulty in having them carted away from the ground floor end of the flue.

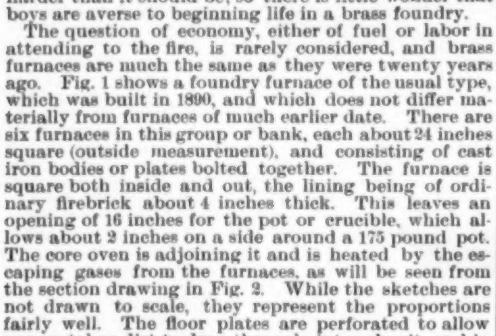


FIG. 3.—SECTION OF FIG. 1.

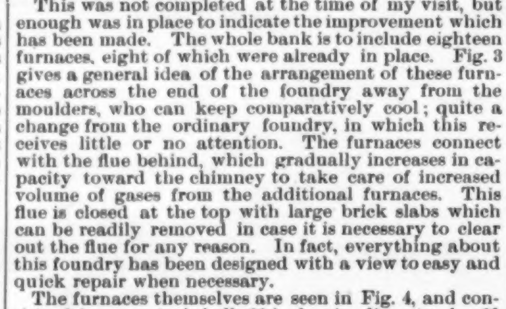


FIG. 4.—DETAILS OF ROUND FURNACE SHOWN IN FIG. 2.

The cover plates in the first case were rectangular, with wrought iron handles cast in them, to be removed by hooks before lifting the pot. Fig. 4 shows the round cover used in the latter furnaces, and, having a round hole in the top, allows the insertion of a hook as shown. These make a very handy furnace in all respects, and one that is economical as well. Other features will be treated later.

It should perhaps have been previously stated that both these foundries are on the top floors of their respective buildings, the former being on the fourth, the latter on the sixth floor. This is such an improvement over the ground floor foundry (when the building is of more than one story) that it is being almost universally adopted. The cost of elevating the fuel, metal, etc., is small as compared with the increased value of the other stories, for the writer knows, from sorrowful and heated recollections, the almost unbearableness of the room over a lively brass foundry; the heat and the disagreeable gases make it particularly undesirable for renting purposes. You may be able to make your own men stand it (and lose money thereby), but no tenant will occupy it without a concession in the rent bill.

* For our engravings and the article we are indebted to Machinery.

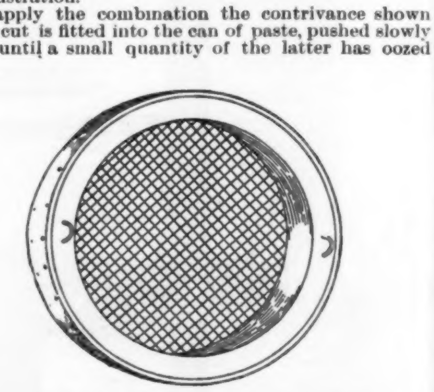
LABEL PASTING.

By JOSEPH F. HOSTELLEY.

IT is the intention in this article to describe a number of simple appliances by the use of which label pasting might be facilitated. These devices, or modifications of same, have been in practical use in our laboratory for many years, and can be justly recommended for their time and labor saving qualities, general utility, and inexpensiveness.

The first is a contrivance for regulating the amount of paste to be exposed to the brush, and is shown in our cut. It was made as follows: From a ⅝ inch board of hard wood a ring was cut, the diameter of which was ¼ inch less than that of the can used and ¾ inch wide. A circular piece of netting, of the kind used for fly-screens, corresponding in size to the outer circumference of the ring, was then attached thereon by means of a circular piece of leather of the exact size of the ring, tacked around the edge of the netting. The face of the ring was then padded by means of a strip of thick cloth tacked to it, which made it fit the inside of the can snugly. Two small staples were then driven part way into the exposed side of the ring, diametrically opposite each other, as shown in the illustration.

To apply the combination the contrivance shown in our cut is fitted into the can of paste, pushed slowly down until a small quantity of the latter has oozed through the meshes of the netting, and allowed to remain at that point until the quantity of paste exposed is exhausted.—Bulletin of Pharmacy.



A NEAT DEVICE FOR THE PASTE POT.

TEMPERING STEEL UNDER PRESSURE.

A DIRECT process of tempering steel under pressure has been brought forward in Germany by Herr Haedicke. There are two methods of performing this; one is by hardening it first by plunging the red hot steel into cold water and then drawing the temper, and the other by plunging it into certain chemical baths. So far the process appears to have been applied only to hand saws and steel ribbons. In the manufacture of saws the steel is first hardened in oil or fat, and then, while still hot, it is placed in a press between hot dies and the temper is thus drawn while under pressure. A special style of press is employed, the die being hollow and arranged so as to allow of the circulation of steam or hot oil. Arrangements are made to regulate the heat. The plates are allowed to cool to the point desired while under pressure.

ENGINEERING NOTES.

The number of railroad men discharged for excessive use of liquor during the past 22 years, according to Chief Arthur, of the Brotherhood of Locomotive Engineers, has decreased from 20 to 1 per cent., and during the past 25 years the proportion of men owning their homes has increased tenfold.

The White Star Steamship Company is having bilge keels fixed on the twin-screw steamer "Teutonic." Some time ago it fitted its cargo steamers with such preventives against rolling, and the application of side keels to one of its crack passenger boats serves to illustrate the popularity which these aids to comfort have attained.

It is calculated that each 1350 pound stamp dropping 100 times per minute will require 2¾ H. P.; each 900 pound stamp, at the same drop rate, 2 H. P., and each 750 pound stamp 1½ H. P. Boiler feed for each H. P. per hour will average five gallons water; each stamp per hour will require from 60 to 75 gallons; each concentrator per hour, 250 gallons.

A large flexible woven suction hose, for a centrifugal pump dredge, has been made by George Angus & Company, of Newcastle-on-Tyne, England, for use in the dredging of sand bars by the Natal government, says The Engineering and Mining Journal. The pipe is 42 inches diameter and 10 feet long, and is made of 1 inch best "yacht manila" rope, extra soft laid. To keep the tube in shape iron hoops 1½ inches diameter were woven into the circumference at intervals of less than 1 foot. The same firm has just shipped a similar suction pipe to East London, Cape Colony. This latter pipe is 27 inches diameter, with 1⅜ inch hoops, 30½ inches apart at the top and 8 inches at the bottom of the pipe, and the pipe was 9 feet 8 inches long, and woven on a curve of 10 feet radius.

In commenting recently upon the punctuality of American trains in The London Times, Mr. W. M. Acworth said: "If I were to give in one sentence the reason why American trains, in spite of great difficulties, are excellently punctual, I should say it was because punctuality is insisted on. Instead of engines being sent out, as often happens here, with trains that they are evidently and notoriously incapable of hauling to time, engines are built powerful enough to play with their trains. I stood one night on the platform of the huge Union depot, at St. Louis, where the trains of 22 different companies converge, and watched one express after another start out. Many of them weighed at least 400 tons, most of them certainly over 300. Yet not once did I see a driving wheel slip at starting."

Carnival "confetti" have decided a curious point in Paris sanitation. Opponents of the sewage farm system at Achères had declared that the drainage in the city was so slow that it took two or three weeks for the sewage to reach the pumping station at Clichy, and that the fermentation going on in that period was dangerous to the health of Paris. At Easter, this year, a great many of the paper pellets, called "confetti" by the Parisians, that should have been used for the carnival were thrown about the street. The main boulevards were swept at 3 o'clock in the morning of the next day, the confetti going into the sewers, and before 11 they began to appear at Achères. By noon the sewage fields were covered thick with them. The passage had taken about eight hours, the sewage traveling five miles, and the fermentation theory was knocked in the head.

The London Road Car Company have placed upon their Hammersmith to King's Cross route a new omnibus with wheels which have been fitted with the roller bearings of the Roller Bearings Company, of Westminster, similar in general principle to the bearings made by this company for the Liverpool Overhead Railway. The hubs are of iron, into the sockets of which wooden spokes are driven, and the bearings, consisting of a series of steel rollers controlled and prevented from cross winding by a bronze cage, enable the car to be moved easily by one man. This experiment will be watched with much interest not only by friends of the horse, but also by those interested in the use of the electric motor on road vehicles; for in either case the heavy strain in starting is considerably reduced by the use of roller bearings, which have already shown themselves of such advantage in tramcars and railway carriages.

Work on the foundations of the new mint at Sixteenth and Spring Garden Streets, Philadelphia, is progressing satisfactorily, and the contractor expected to complete this part of the work in contract time, August 15. The details of the contracts above the first floor are now being worked out in Washington, and it is expected that bids will be asked for within a month. This contract will include the immense piers to be constructed within the square around the boiler house to support floor girders. On account of the treacherous nature of the ground, much difficulty in securing a solid foundation is looked for. A Philadelphia firm has been awarded the contract for the great silver vault to be located on the Spring Garden Street front, west of the main entrance. It will be 10 feet in height, running 53 feet along Spring Garden Street and extending back toward Buttonwood Street to a length of 102 feet. It will cost $140,000.

The noise and also the disagreeable odor of gas and petroleum engines have, according to The London Engineer, been suppressed in a very satisfactory degree by M. Chevalet, who places inside of, or on the top of, the cast iron chamber in which the products of the explosion are generally received a few scrubber rings, such as are used in gas works. A considerable diminution of the noise was effected by a scrubber 40 centimeters (15¾ inches) diameter placed over a 3½ horse power petroleum engine, and also upon a 1 horse power gas engine. With the latter class of motors it is not necessary to sprinkle with oil the shavings on the plates of the scrubber, but with a petroleum engine this precaution should be taken. Disagreeable odor is thus almost completely suppressed, if a naturally inodorous oil be used for the sprinkling; and this oil may serve for lubrication, after having been freed by settlement or decantation, or by filtering, from the solid matter which it may have drawn along when traversing the plates and shavings of the scrubber.

ELECTRICAL NOTES.

It is figured that there are 6,000 railroad cars in Europe lighted by electricity, while the number in this country is sensibly rated at much less than 1,000. The European statistics seem very much open to doubt.

The first electric street railway in China will connect Pekin with the suburb of Machiapu, connecting with the existing railway line to Tientsin, the seaport of Pekin. Two trains are run daily from Machipu to Tientsin. A German firm has secured the contract for the new electric railway.—Uhland's Wochenschrift.

The first electric mountain railway in Austria will be the highest railway in Europe, reaching an altitude of 2,746 meters (about 8,500 feet). The line will lead to the summit of the Amthorspitze (Tyrol), and 400 horse power will be taken from the Eisack River to drive dynamos and motors. The electric motors will be stationary, operating on a cable which will propel the cars.—Uhland's Wochenschrift.

In an article in The London Electrician on "The Telephone in Italy," the tariff in Florence, where there are 900 subscribers, is given as the equivalent of $30 per annum within 1,000 yards of the exchange, running up by steps as the distance increases. An interesting fact is that the switchboard operators receive a salary (?) of from $6 to $12 per month, working seven to eight hours per day. Linemen receive from 40 to 50 cents per day for ten hours' work, extra time being paid for at the rate of 4 cents per hour.

To renew an ordinary commercial dry battery when exhausted it is only necessary to perforate the sides and bottom with a dozen or more holes, the simplest method of accomplishing this being with the aid of a steel wire nail and a hammer. The battery should then be placed in a vessel containing water, and it will be ready for almost immediate use with a new life as long or longer than that already obtained. In renewing a battery of such cells they should not, of course, be placed in the same vessel of water, as the shell of the battery is one electrode, unless all the cells are placed in multiple. In case they are in series connection, they should be placed in separate vessels, and if the latter are metallic, they should be insulated from each other.—Electrical World.

A New York occulist is reported as saying that Americans are too reckless of their eyes in exposing them to the electric light rays, and if a reform is not had, a sightless race may be developed. A temporary remedy is proposed in the placing of the incandescent lights higher—so as to be further from the eye—and the use of ground glass or other globes that will give more or less diffused light. But this expert insists that the real cure lies in a more sweeping measure. He adds: "The proper thing to do is to abolish electric lamps altogether. Their general use has been of too short a duration for us to realize the actual extent of their injury to the human eye, but if they continue to be employed, we shall realize our mistake when it is too late. What should be used are fluorescent tubes, which cost no more than the present electric lights and which give a steady light. In fact, I would not be surprised to see fluorescent tubes in general use throughout New York city within a short time." It is said that arrangements are being made to light an entire block in New York by fluorescent tubes.

During its manufacture, says Le Papier (Paris), paper is often charged with electricity by the friction of its passage over the drying-cylinders and other parts of the machine—an inconvenience which makes itself felt when the paper is used. Efforts have been made, without much success, either to extract, to prevent, or to neutralize this electric charge, by putting the roller in electric contact with the ground and by placing near the paper, at the moment when it leaves the machine, a metal point that attracts the charge. Messrs. H. J. Rogers and V. M. Morday have discovered, as the result of a series of experiments, that the lack of success of these processes must be attributed in general to the insufficiency of the means employed, and especially to the fact the paper is charged with electricity, not only on the surfaces, but also internally. The discharge of the electricity on the surfaces is ineffective because, after this discharge, the interior charge is eliminated slowly, and because the surface of the paper is thus subjected anew to electric influence. The inventors, having thus taken account of the causes of the ill success of their predecessors, have reached a satisfactory result by using very large discharge-spaces and by offering to the surface of the paper numerous discharge-points disposed in such manner as to act during a sufficient time to remove the electricity not only from the surfaces, but also from the interior.

An interesting application of the principle of the rotating magnetic field to signaling apparatus is described in a recent issue of The Electrician. This signal system, due to Dr. L. Weber, is intended to replace the step-by-step devices now used for many purposes, but especially for the purpose of signaling between bridge or pilot house and the engine room on ships. Similar dials are used at the ends of the line in these devices, the signal being given by moving an index lever over the dial at the sending station and causing a corresponding movement of an index hand over the revolving dial. In Dr. Weber's device the sending instrument consists of an endless resistance helix, arranged in a circular form on the dial, and wound on a resistance frame in the manner of a Gramme winding. This resistance is tapped at three equidistant points by three conductors, which are led to the receiving dial. Here they are connected in the three-phase star fashion with three radially-disposed magnets controlling a small two-pole armature of soft iron attached to an indicating hand. The current energizing this receiving instrument is furnished and suitably distributed by the sending instrument already referred to by an index lever, pivoted in the center of the resistance helix, and furnished at its ends with contact pieces touching on the opposite ends of a diameter of the resistance, these contact pieces being terminals of an electric source, the current from which is differently distributed in the three circuits, and therefore in the magnets of the receiver with every different position of the transmitter lever.

SELECTED FORMULÆ.

Coloring Brass.—To color brass a blue-black steel color, the articles should be well cleaned and immersed in a boiling solution of chloride of arsenic. If very carefully cleaned, the articles may be colored azure blue by immersion in a concentrated solution sulphite of soda. A deep blue-black may be produced by immersion in a solution of carbonate of copper and ammonia, and subsequent exposure to air. But hyposulphite of lead and soda will give many variations of color. To 100 c. c. of a 10 per cent. solution of hyposulphite of soda 5 to 6 grammes of sugar of lead are added. Dissolve by heat, filter, and heat again to 70° C. When first plunged in this solution, brass assumes a golden color, and then passes through various shades of orange, vermilion, scarlet, and violet, at last to azure blue. Further action will change the blue to a silver-gray color. A matt black may be produced by immersing brass in a weak solution of chloride of platinum and nitrate of tin; bronze color, by immersion in a boiling solution of sulphate of copper and alum. A golden color may be also given by treatment with 4 parts of caustic soda, 4 parts of milk sugar, and 100 parts of water. In all cases, as soon as the requisite color is attained, the articles are at once transferred to clean water and rinsed. After drying, they should be coated with celluloid varnish.—Photographische Chronik.

Gilding Copper Articles.—The following paste is spread on evenly after the articles have been washed free from oxide: Dissolve potassium cyanide, 30 grammes, in a little distilled water, add sodium gold chloride 10 grammes, then purified potassium carbonate in finest powder 6 grammes, and finally precipitated chalk 55 grammes. Add sufficient water to form into a soft paste. After the articles are satisfactorily coated, rinse several times in clear water, and dry them in sawdust.—Pharm. Centr.

Machinery Polishing Paste.—The following paste is recommended for polishing machinery and iron or steel ware:

	Parts.
Oil of turpentine	5
Paraffin	25
Finest emery	25
Fine powdered animal charcoal	45

The paste thus formed is thinned down with methylated spirit, then applied to the parts to be cleaned with a brush. When the spirit evaporates, the surface is well polished.—Apotheker Zeit.

Sticky Fly Papers.—The following proportions are given for preparing "sticky" fly papers:

Resin	550	500	650	600	500
Linseed oil	350	300	...	...	...
Castor oil	...	...	350	300	340
Honey	100	200	...	100	...
Glycerin	...	...	...	...	160

Melt together and smear on paper while warm.

The addition of strong decoctions of pepper or quassia chips or tarter emetic to the honey kills the flies quicker.—Pharm. Centralh., xxxviii., 448.

Very satisfactory cement for leather belting has been manufactured by kneading 10 parts of carbon bisulphide and 1 part of oil of turpentine with gutta percha until a thick paste is the result. The portions of the leather where the cement is to be applied are to be unrolled and roughened, the cement put on, and the ends pressed together until the binding agent has become dry. Good caoutchouc cements, too, for rubber strips or rubber goods on metal are obtainable by dissolving shellac in ten times its weight of ammonia, and, after standing for three or four weeks, a transparent putty results, which is used without heating. The cemented places soften at first, but become hard and firm after evaporation of the ammonia, which may be assisted by heating. This cement is watertight and gasproof, and is efficient for hard rubber articles—a mixture of gutta percha and asphalt being also serviceable in the same line.—Engineering and Mining Journal.

Non-Dangerous Fireworks.—Weiffenbach, Stuttgart, Germany, has recently patented a "firework giving a non-dangerous spray of blinding white light." It is produced by mixing together 12 parts of aluminum filings, 12 parts of barium nitrate, 12 parts of saltpeter, 2 parts of yellow dextrin, 2 parts of sulphur, 5 parts of gum arabic, and filling the mass, dry, into tubes, or the mass may be made into a paste with water and spread on any suitable articles.

Mosquito Killing Pastilles.—

(1)	Carbolic acid	4·0	grammes.
	Potassium nitrate	6·0	"
	Insect powder	25·0	"
	Wood charcoal	50·0	"
	Tragacanth	9·3	"

Make a mass and form into pastilles, which are to be ignited in the infested room.

(2)	Benzoin	100	parts.
	Balsam tolu	100	"
	Charcoal	500	"
	Insect powder	150	"
	Saltpeter	50	"

Make into a mass with water and form pastilles as above.

Dieterich gives the following:

(3)	Potassium nitrate	1⅛	ounces.
	Mucilage of tragacanth	2	fluid ounces.
	Insect powder	2	ounces.
	Althæa, powdered	125	grains.
	Tragacanth	125	"

Intimately mix the potassium nitrate with the mucilage; also mix the other ingredients together, then incorporate the powdery mixture with the paste, divide the whole into pastilles weighing 30 grains, and dry at a temperature of 20° to 25° C. The pastilles may be bronzed or gilded, if desired.—Pharmaceutical Era.

Label Gum.—

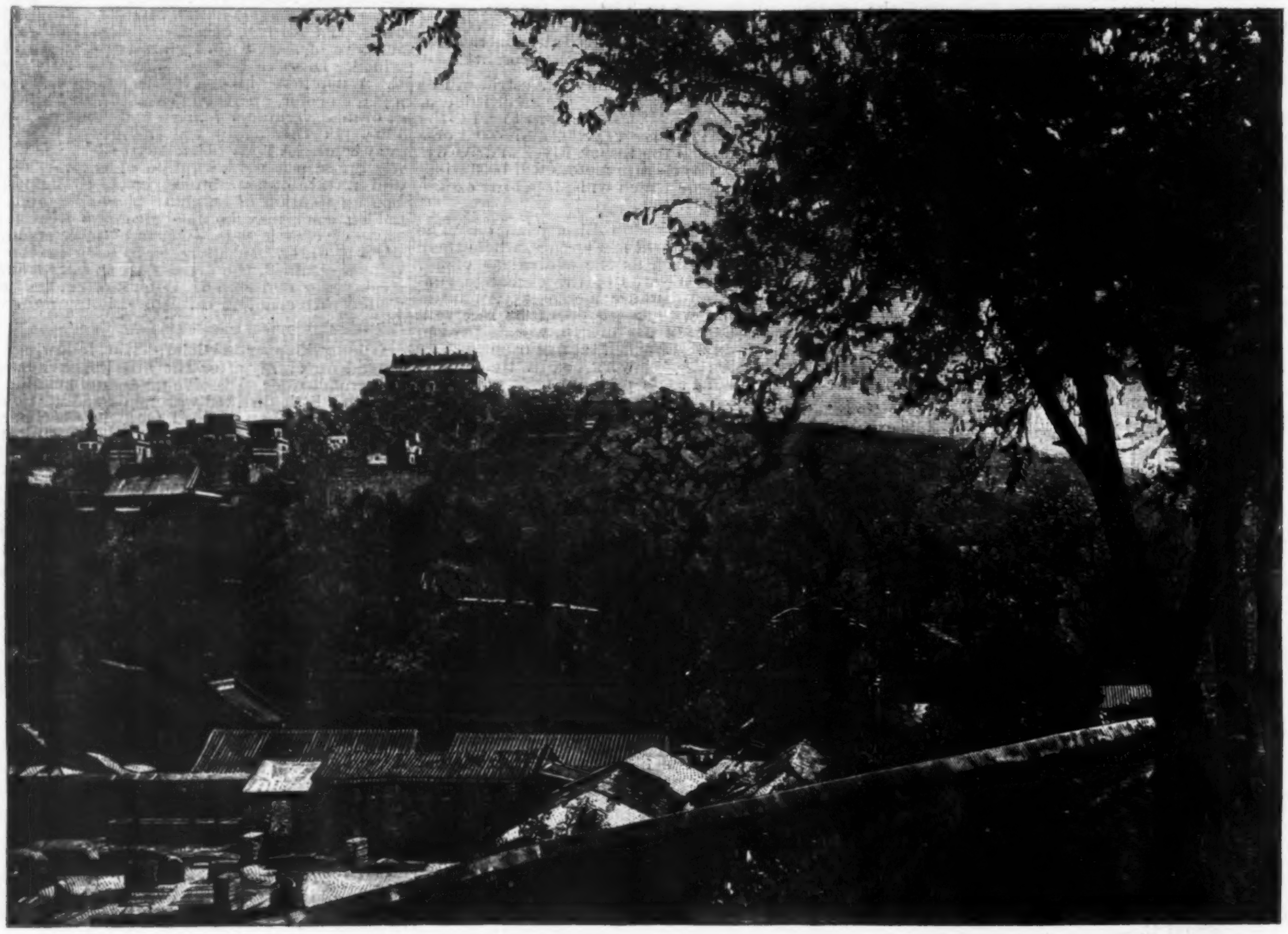
FOR PAPER TO GLASS.

a.	Pulverized gum arabic	4 ounces.
	Boiling water	6 fl. "
b.	Glycerin	2 fl. "

Dissolve a, then add b.

PRINCE HENRY OF PRUSSIA IN CHINA.

WHEN Prince Henry of Prussia was at Peking, his time was well filled with dinners and other entertainments that were tendered him, to say nothing of the sightseeing, which interested him very much; but the chief event of his visit was his reception by the Emperor and Empress at their summer palace, Wan-Shu-Shan, which is situated outside of the great wall that surrounds the city. There are some other fine structures still standing outside of this wall, but many were destroyed long ago in the wars with the French and the English, and even those which were left have been neglected by the Chinese, so that many of them are now in a state of ruin. It is said that during his audience with the Emperor the prince emphasized the fact that the weakest point in the government of China is the undisciplined condition of the army, although the prince was much pleased with the soldierly bearing and fine appearance of the corps which was reviewed by him and his staff during their stay in Shanghai. This corps had been under the instruction of German officers for the past two years, but recently they have been paid off and their connection with the Chinese



WAN-SHU-SHAN, SUMMER RESIDENCE OF THE EMPEROR OF CHINA.

WAN-SHU-SHAN AND LAKE.

army severed; and now it is feared that when the troops have been for a time under their own military mandarins, they will soon lapse into their old ways. This has always been the case with Chinese regiments that have been drilled by foreign officers.

We publish two engravings of the Emperor's summer palace, Wan-Shu-Shan, for which we are indebted to the Illustrirte Zeitung.

ATTRACTIVE WAKE ISLAND.

IT has been recorded that Gen. Greene, with a strong landing party and a few officers, went ashore on Wake Island on the Fourth of July, took an observation, made a map, planted a record of possession, and raised the flag of the United States. We are informed that he found no trace of inhabitants, that none have been there for sixty years, and that the island has long been lost. It has been hinted that, sailing on a parallel and not on a great circle, he must have had a reason for going there. His triangulation, map, and observation of position will certainly be of scientific interest.

Wake Island is supposed to be the Desierta, that is, the "desert," and La Mira, "take care," of the charts of the Spanish galleon taken by Anson in 1743. It was discovered in 1796 by the "Prince William Henry," and is found on the chart that accompanies Perouse's voyages, published in 1797. It is often seen and reported as a reef or an island under various names, Wake, Week, Halcyon, Helsion, and Wilson being the most frequent. It is not to be confounded with Weeks Island or with another Wake Island on the western coast of Patagonia. The mean of the positions reported is 19 degrees 19 minutes north, 166 degrees 39 minutes east.

Wake Island is nearly or quite awash in heavy gales; very low and steep to seaward; from 9 to 20 miles in circumference, according to wind and tide. The larger portion of it is a lagoon. The vegetation is very scanty, and there is no fresh water. The only food to be found consists of a few birds and plenty of fish.

Wake Island has been examined by Wilkes of the United States Exploring Expedition, by English of the United States Navy, by Sproule of the "Maria," by Cargill, by Wood, by the missionary ship "Morning Star," and by many others; and thirty-two years ago it was "inhabited" by some who can tell you all about it to their sorrow.

The Bremen bark "Libelle," bound from San Francisco to Hongkong with passengers and treasure, having touched at Honolulu, was cast away on Wake Island on the night of March 4, 1866. The passengers and crew remained on board during the night, the sea breaking fearfully over the wreck; and on the following day they landed with difficulty through the breakers. For three weeks, amid terrible privations, they searched in vain for water, and were at last obliged to take to the boats. But the breakers were still encircling the island, and they were several days in getting away. They reached the Ladrones in May, and were entertained by the governor, who sent a schooner, under the guidance of the master of the lost vessel, to procure the treasure left on Wake Island. They were two days in finding it, the marks erected on the spot having all been thrown down and washed away by the sea. Anchoring 110 yards from shore, the Ladrone schooner found 21 fathoms inside and no bottom outside, with 35 fathoms line, showing that Wake Island rises abruptly out of a deep sea.

Wake Island was described by Capt. Sproule, in 1848, as a very dangerous spot lying immediately in the track of vessels from Peru, Central America, and the Sandwich Islands, and in a part of the ocean where vessels are generally running fast before the wind. "At 5 P. M.," he says, "the lookout on the foretopgallant yard saw low land on the starboard bow. I went aloft and saw from the topsail yard a very low island, rather higher in the center than at the ends, and covered with low bushes. It was dark before we approached it sufficiently near to make observations, but I am confident it would not be seen more than 5 miles off deck by daylight, and in a dark night never in time to avoid it."

The famous Wilkes expedition westward from San Francisco to New York hove to off Wake Island on the night of December 19, 1841, and in the morning after breakfast a number of boats were sent ashore to make a survey. They reported a coral island, not more than 8 feet high, and apparently at times submerged. The fish in the lagoon included some fine mullet. The birds were few in number, and very tame, and "Mr. Peale found here the short-tailed albatross, and procured an egg from its nest." There were low shrubs upon the island, but no fresh water, and neither pandanus nor cocoanut trees. The outlying reef was very small. "Our visit to Wake Island gave us an opportunity of adding to our collections in natural history. By 4 o'clock all the boats had returned and we filled away and proceeded on our course to the westward."—New York Times.

AN EIGHT-LEGGED LAMB.

M. G. CLEMENT, of Apt (Vaucluse), recently sent to La Nature a photograph of an eight-legged lamb, which that journal reproduced, and of which we present a copy herewith. Figs. 1 and 2 give, respectively, a general front and rear view of the monstrosity.

FIG. 1.—FRONT VIEW.

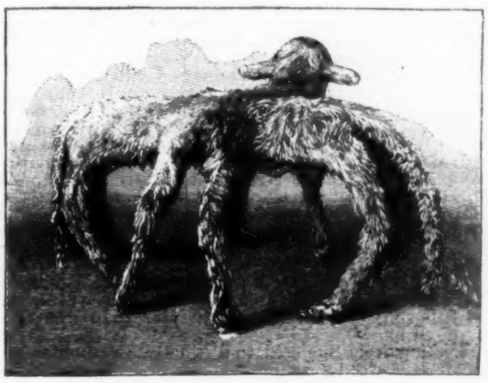


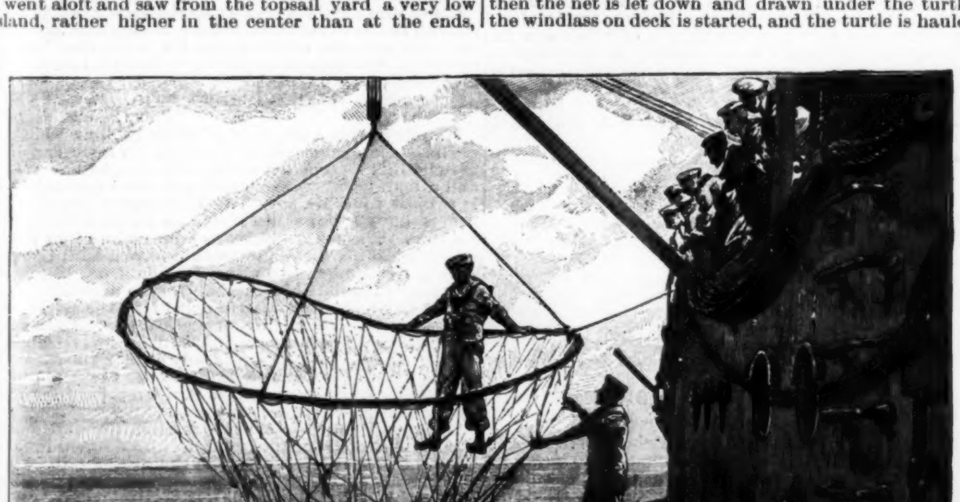
FIG. 2.—REAR VIEW.

AN EIGHT-LEGGED LAMB.

The animal was of the female sex, and had a well-shaped head, a normal breast, and two legs in front and three bodies in the rear. These bodies were symmetrical, each having two legs, and were very well formed. This triple animal lived but a few hours, the spine having been broken during its birth. The photograph was taken from the animal after it had been stuffed.

TURTLE FISHING IN THE PACIFIC OCEAN.

THE commander of the German Pacific squadron that cruises off the coast of Mexico has found a pastime for his crew which is as original and amusing as it is profitable. He has constructed an apparatus for catching turtles which, for simplicity and practical usefulness, has no equal. As is shown in the accompanying engraving, it consists of a drag-net operated by means of a tackle. All of the sailors that are off duty watch diligently, for the one who first discovers the booty receives a little premium. As soon as a swimming turtle is discovered, the ship is brought near to it and then the net is let down and drawn under the turtle, the windlass on deck is started, and the turtle is hauled on board. Then for a time there is turtle soup and tender turtle meat. But the sport has other advantages to recommend it, for it teaches facility in maneuvering the ship, giving both the officers and men excellent practice in change of speed and in stopping suddenly.—Für Alle Welt.



TURTLE FISHING IN THE PACIFIC OCEAN.

AMERICAN PROGRESS IN ENGLISH INDUSTRIES.

A GREAT deal has been heard of late about the progress of Germany as a rival to industrial England. So much has this been the case that the bitter cry of American competition seems to have been overlooked. All the same, it would not be far from the truth to say that British industry is pressed harder by the Americans than by the Germans. Many of our Sheffield manufacturers, although America is no longer the key to the Sheffield trade, have intimate relations with the United States, and go there regularly on business several times a year. The more they go, the more they are impressed by the fact that transatlantic firms, both in their methods of working and in the way in which the artisans do their work, are far ahead of this country. A leading Sheffield manufacturer, who makes very frequent visits to the States, is especially emphatic on the superiority of American machines and the way they are worked by American workmen. There are other considerations to which he also attaches importance. One is the lighter taxation the producer has to support in the States. For example, there is no income tax; such statutes as the Workmen's Compensation Acts, which materially add to the cost of production, are unknown, and even the trade unions are worked under conditions much more favorable to the American manufacturer than those prevailing on this side in respect of the British manufacturer.

The whole principle upon which automatic machines are worked is quite different. In England the express purpose is to let the machine do as little as possible. There could have been no more striking example of this than during the late engineers' strike, the crux of which may be said to have been a resolute attempt to slow-time the machine. In the United States the free use of automatic machinery is the chief factor in the different industries, the workman being anxious to beat the record in the utmost amount which can be got out of his machine. One man may be found looking after half a dozen machines, and even boys are often seen working in the same capacity. Another point is that in the United States there are four classes of workers—the Americans proper, the Germans, the Irish, and what are lumped together as the "niggers." These four classes never coalesce. If the Americans do not work properly, out they go, and the Germans come in. If the Germans give trouble, out they go, and the Irish come in; and if the Irish do not work as they are wanted, out they go also, and their places are taken by the "niggers." In this way there may be said to be competition of the most practical and useful kind between the different classes of workmen and the different unions in the various workshops. This is the very opposite to what prevails in England, where the most popular workman with his colleagues of the trade society is the one who can contrive somehow to make his labor-saving machine save as little labor as possible.

Furthermore, rates and taxes are generally far below anything imposed in this country. The amount raised being supplemented by the import duties, which are borne proportionately by the employer and the employed, the lighter taxation is sufficient for State purposes. The further West one goes, the lower are the rates, there being places where the States, in the anxiety to foster native industries, offer remarkable advantages to stimulate commercial enterprises, one of these advantages being to free the enterprise from taxation for a period of years. The principle the United States adopts is as far as possible to make the foreigner pay. The foreigner, for instance, is largely paying for the extra war liability. A few examples of these taxes may be mentioned, viz., a cent tax for all telegrams and all settled bills; a 10 cent stamp on all bills of lading; a passenger tax levied upon all persons leaving United States ports; a first-class passenger pays \$5, second-class \$3, and steerage \$1. Although part of that taxation falls on the American, no small portion has to be paid by the foreigner. A moment's reflection upon the enormous exports and passenger traffic from the States to Europe, and particularly to England, will suggest the value of the revenue raised from these specific sources.

Now and again we hear of steel and iron being sent from America to the Old World, but the explanation usually given is that this is simply "bounce," or by way of advertisement on the part of the United States manufacturers. "It does this country no good," said a leading Sheffield manufacturer, "to ignore the truth in this way. At this moment the American is sending over in the regular way of business heavy consignments of steel. True, these are mainly in the cheaper grades, but the time will come when they will be sent over in the costlier qualities." He mentioned that a single firm in London is now receiving United States steel at the rate of nearly 250 tons per annum. Ameri-

can steel, he added, is also being sent into Birmingham in very large quantities. It is mainly used for bicycle work. In bright-drawn steel for bicycle purposes, for nuts, screws, and bolts, or anything that can be made in large quantities by means of automatic machinery, the American steel is preferred, not merely by the manufacturer, who finds it lower in price, but generally by the workman, as its uniform temper enables him to work it smoothly right through, with considerably less wear on the tools. That the influx of steel from America is not mere "bounce" or "advertisement," is evident by the concern shown by some of our manufacturers. At the last meeting of the Ebbw Vale Steel, Iron and Coal Company, Limited, Wales, one of the directors stated that there would be anxiety for some time to come in connection with the steel works, owing to the new appliances and the improved methods in America and on the Continent, as well as the keenness of competition. Another director —who is also a director of a large steel concern in Sheffield—attributed the serious period of depression which had fallen upon the Ebbw Vale Steel Works to the flow of steel from America into this country.

Some time ago a Sheffield manufacturer asked us to look at several large consignments of American-made files he had just received. Several of these were in the finer and smaller sizes which are only produced in this country at prices very much higher than they can be delivered from England to the States. Undoubtedly the American file is lighter than the British, and the objection to it on this side is that it cannot bear recutting; but, as this manufacturer explained to me, files can be made at such low prices now-a-days that few people trouble themselves about recutting at all. As for prices, Sheffield manufacturers charge considerably higher than the Americans in most sizes, and many of the workers on brass, iron, and steel prefer the American. The foreign files are said to be particularly favored in the great districts where the textile trades are carried on, and the quantities now being received in London and Birmingham, the principal distributing centers, are far greater than even the trade supposes.

Passing from Sheffield to distinctly Birmingham industries, a word may be said about brass rods. By these we mean the form in which the brass is supplied for making brass unions, etc., out of solid rods, round or hexagon. It is no pleasure for the British manufacturer to find himself compelled to use American-made brass, but he claims that it is drawn so much truer than the English that it can be worked in automatic machinery with much less trouble and with greater economy. Asked as to the price, a leading manufacturer stated that it is from 15 per cent. to 20 per cent. cheaper than the English. In another article, which is rapidly growing important—steam India rubber hose piping—one authority said he had the American make delivered on his premises at 20 per cent. to 25 per cent. cheaper that the English makers had supplied. Here it is only fair to say that the railway rates help the foreigner, the rate from New York to Liverpool being positively lower in several instances than from Liverpool to Sheffield.

Another item may be mentioned—the smaller sizes of malleable iron castings. American firms are at this moment delivering these castings in Sheffield at full 30 per cent. below local prices. Here again it is but right to admit that the railway rates materially assist the foreigner. It will not do to say, however, of these castings that they are simply sent over by way of "advertisement," or that they are not of good quality. The very opposite is the case. They come over in the regular way of business—a business which is steadily increasing—and they come over of such quality that the workmen themselves are openly heard to confess their preference for the American production. In one of the establishments where they are used in very large quantities we asked various workmen, as we passed from place to place, which they preferred—the American or British casting. Although "Yankee notions" are as little in favor with the British worker as things "made in Germany," the invariable reply we got was that the American casting was preferred because it was truer and more uniform in quality. The users, too, mention another difficulty which is surely capable of prompt remedy. That difficulty is to get adequate deliveries of these small malleable castings where large quantities are required. The head of one house told us that he has often been disappointed in not getting his order completely filled, and in the end has had to send a cablegram to American manufacturers, who have sent him all he wanted in a much shorter time than he could have got them within a few miles of his own door. It is impossible for anyone who is much in the habit of visiting the large industrial establishments of this country to avoid seeing how rapidly American labor-saving machines are being utilized. Specific instances are constantly coming to our notice of this; instances where British manufacturers, who have been fighting all their lives against using American machines, have lately, through failure to get what they wanted in England, been compelled to adopt foreign-made lathes and other special machines, and now they say they would not be without them.

The business of supplying these American inventions to British industries is only just beginning. It is not to the interest of British manufacturers to admit this much, but they are gradually being forced to the conclusion that there is no denying the advance of the American, both in his methods of production, his application of those methods in the use of the machinery by which they are applied, and the men by whom they are worked. The head of one of our large Liverpool shipping firms remarked to a leading manufacturer the other day that he had observed for some time with no little misgiving that the vessels of his line were going out less laden with English manufactures, and every time they returned they were fuller than ever of American productions. It is significant of the trend of business when a gentleman who is not engaged in British manufactures himself cannot fail to observe a change testifying so clearly to the march of the American. A little healthy discussion on this subject would be seasonable, and might bring out the truth in other directions than those indicated in this article.

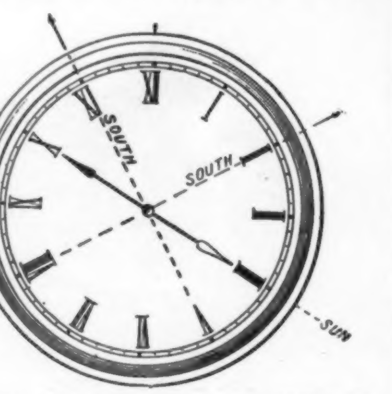
In Eastern Australia one hundred million sheep now find sustenance in a region which, thirty years ago, was a sandy desert.

HOW TO USE A WATCH AS A COMPASS.

FOR the information of those who, like myself, are fond of hunting, and in their zeal apt to lose all directions in the woods, I give my method of finding my way back again. There are two requisites necessary—the sun and a pocket watch. Of course, a man who knows the four points of the compass can come out of the woods with the assistance of the sun; but with the help of his watch he can do it much better and more exact.

If it is in the morning and you want to come out of the woods in a southern direction, take your watch, open it, and hold it in your hand, face up. If the small hand points at ten o'clock, for instance—it does not make any difference where the large hand points to—set the watch so that the small hand points straight to the sun, so that the shade will be easily under the small hand. Now take the distance from X to XII, divide into equal parts, and the result is XI, which points to the direction you want to take if you want to go south. If your destination lies in a northerly direction, follow the direction given by V, the opposite of XI.

If it is toward evening and you want to find your



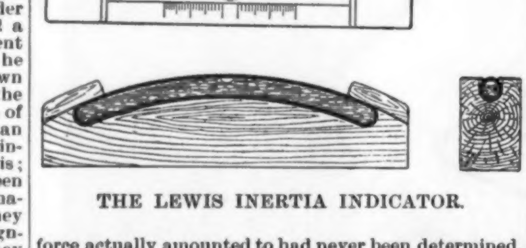
HOW TO USE A WATCH AS A COMPASS.

way home, place the watch so that you get the shade under the small hand, the same as in the morning. If the small hand points to IIII, divide the distance from IIII to XII around the nearest way, the result of this being II, which gives you the direction you have to go if you want to go south, the direction north being indicated by the opposite, VIII. This is one method to find your direction when you have a watch with you. Another method is given by nature itself. Look at the straight giants of the forest, and you will find that on the side where the bark is darkest the northerly winds are blowing, while on the side where the bark is light the wind blows from the south. This may not be very practical information for men who look for workshop experience, but then it is not fair to have all work and no play.—L. H. Avey, Plaquemine, Louisiana, in New York Blacksmith and Wheelwright.

A NEW INERTIA INDICATOR.*

By WILFRED LEWIS.

ABOUT a year ago I was called upon to investigate the strength of a runway intended to carry a modern traveling crane. There was no question about the ability of the columns and girders to support the maximum load in any position, but grave doubts were entertained as to whether sufficient lateral strength had been provided to resist the inertia of the crane in starting and stopping. It can readily be understood that a mass of fifty or one hundred tons moving on a runway 40 or 50 feet high must, under the influence of powerful motors, have a dangerous tendency to overthrow the structure; but just what this horizontal



THE LEWIS INERTIA INDICATOR.

force actually amounted to had never been determined. In my practice I had commonly assumed it to be about 10 per cent. of the moving weight, and this assumption was based upon the proportion of load carried on drivers and the probable traction of those drivers. As traveling cranes, when properly handled, do not often slip their drivers and throw the bridges out of square, I concluded that the force exerted was generally less than the friction of wheels on rails. In locomotive service this friction is known to be about 25 per cent., and as only half of the weight of the crane comes on its drivers, the maximum traction would appear to be about 12½ per cent. of the whole weight. Something should be deducted from this in starting, and the same amount added in stopping, for the journal friction in the trailing wheels; but as long as the drivers do not slip, the effect is surely less than the maximum possible, and, therefore, I had assumed 10 per cent. of the weight as a rough and ready approximation to the horizontal force in question.

I knew, however, that traveling cranes do sometimes get out of square, and to be sure that the runway under consideration was not deficient in lateral strength it was important to demonstrate in a practical way the actual force of inertia to be anticipated.

* A paper read before the Engineers' Club of Philadelphia.—From the Iron Age.

It was suggested by my colleague in the work that this force might be estimated from a determination of the space and time required to stop a crane running at full speed, and, accordingly, experiments were made on the most available crane at our command with this end in view. A chalk line was drawn on the wall of the building, and at the instant of passing this line at full speed the operator was instructed to stop the crane as quickly as possible. An observer with a stop watch noted the time in stopping, and the distance traversed beyond the chalk line was measured. These experiments indicated, as I remember, that the horizontal force exerted in stopping was about 15 per cent. of the moving weight—a value that accorded well with the maximum frictional resistances assumed. The method, however, necessitated simultaneous action and observation by two or more participants, and, as the time was measured in seconds and fractions, there was apparently room for considerable error in the result, by reason of personal differences in precision.

It was doubtful, also, whether the retarding force could properly be considered as uniform during its period of action, and even the yielding in the runway to the force put upon it seemed to claim some consideration. It then occurred to me that a pendulum attached to the crane would tend to indicate by its position the horizontal force applied, but a difficulty at once appeared in controlling its vibrations without affecting the accuracy of the readings desired. A pendulum necessarily has weight, and in moving quickly it would surely acquire momentum tending to make it overrun its true position. Endeavoring to avoid this difficulty, it then occurred to me that a spirit level is really an inverted plumb bob, and that in the air bubble I had, practically, the pendulum without weight that I wanted.

To indicate horizontal forces I could easily give the tube the necessary curvature and graduate it. Accordingly, I had an instrument made and graduated in degrees from which the tangent of the angle could be taken for the horizontal force required. A later form of the instrument, here exhibited, is graduated, not in degrees, but in a scale of tangents, so that the horizontal force is read at once in terms of the weight moved. No special care is required in its construction, because the method of graduating takes care of any irregularities that may exist in the curvature of the tube. It is important, however, that the size of the air bubble be proportioned to the size and curvature of the tube employed. A large bubble has some tendency to distort and overrun the mark, while a small bubble is unnecessarily sluggish in its movement. A bubble of the proper size will be quick and accurate.

On traveling cranes this indicator has shown effects ranging from 2 to 15 per cent., depending upon the method of driving. Power applied through friction clutches is more sudden in its action than a motor directly coupled, and the resistances used in the starting box naturally affect the acceleration or retardation of the motor.

In steam or trolley cars the indicator may be laid in the window sill in the direction of motion, and the force used in starting or stopping will be shown. In these cases a correction is often required for the grade of the track, which can be read off when the car is at rest. On way trains the force used in starting is about 3 per cent., and in stopping about 12 per cent., while on trolley cars about 12 per cent. of the weight is used both in starting and in stopping. The indicator shows at all times the effective accelerating or retarding force, and when the speed is constant the bubble stands at zero. As applied to traveling cranes, the sway of the runway is included in the result observed, and no corrections need be made. A swinging load introduces some uncertainties, but the maximum disturbance from this cause will probably not exceed that of the same load rigidly attached.

Other uses for the indicator might be suggested, but enough has been said to illustrate its application, and as a new and convenient device for measuring inertia effects it has been thought of sufficient interest to bring before the club this evening.

No other large city is as quiet as Berlin. Railway engines are not allowed to blow their whistles within the city limits. There is no loud bawling by hucksters, and a man whose wagon gearing is loose and rattling is subject to a fine, says The Washington Post. The courts have a large discretion as to fines for noise-making. The negro whistlers who make night shrill and musical in Washington would have a hard time of it in a German community. Strangest of all, piano-playing is regulated in Berlin. Before a certain hour in the day and after a certain hour in the night the piano must be silent in that musical city. Even during playing hours a fine is imposed for mere banging on the piano. In Berlin it is only during the carnival and on fête days that the sound of the French horn is tolerated. At other seasons it is rigorously prohibited by the police. German intolerance of noise is not a recent thing. Wallenstein, who demanded absolute quiet, had one hundred and thirty houses torn down in Prague and sentries posted all round in the distance, to secure silence. There is a tradition that farther back in time a Bohemian shepherd, seeing the monk Adelbert asleep, blew on his pipe in mischief. The monk called down the curse of deafness on him.

Paris's 1900 exhibition will be the sixteenth held in the city. The site of the first, in 1798, was the Champ de Mars, where 110 exhibitors showed their wares in wooden booths and twenty-five medals were awarded. Three successively larger exhibitions followed in the Louvre in 1801, 1802, and 1809. Under the Restoration there were exhibitions in 1819, 1822, and 1827, also in the Louvre. They became more popular under Louis Philippe, the number of exhibitors making it necessary to use first the Place du Carrousel and in 1839 and 1844 the Champs Elysées. The 1849 exhibition in the Champs Elysées required 2,200 square meters of space and cost $120,000. The first international exhibition in 1855 brought about the construction of the Palais de l'Industrie, that has just been torn down, which was also used for the 1867 exhibition. The 1878 exhibition, with 52,835 exhibitors and 16,000,000 visitors, and that of 1889, with 55,486 exhibitors and 32,500,000 visitors, were held on the Champ de Mars.

CHARLES GARNIER.

PARIS has lost not only an able architect, but her representative artist. The picturesque figure of Charles Garnier appeared to be a necessity in any assembly where the arts were recognized. It was no less essential in any picture which was intended to suggest the intellectualism of the city for his strongly marked features to be introduced. Many qualifications were required to attain so much prominence, and they were united in the architect. He was a Parisian by birth, he won his position by merit, he was witty, good natured, capable, but, above all, he never made a pretense of taking things too seriously. To the last there was much of the gamin about him, and he spoke and acted as if he believed the streets of Paris were equal to a university in affording instruction to all who cared to learn. He had to contend with imperialist, communistic, and republican officials, but he contrived to hold his own against them, and to bring his Opera House to completion without any serious disturbance of his own idea. If within the last year he had to succumb in the arrangements for the introduction of engines for electric lighting, it was owing to a sort of conspiracy of dull people. Against stupidity, said the Greek proverb, the gods are helpless, and Garnier was defeated because, for the first time, he was compelled to encounter authorities who were deficient in respect for art, and who were therefore invulnerable in a place where even the redhanded communists were susceptible.

But regret for his loss will not be confined to Paris. Charles Garnier came nearer to being a universal favorite than any other man in the profession. There is no country where his name was unknown, and among the expectations which would have hold of foreign architects when arranging a visit to Paris in 1900, the chance of seeing and hearing Garnier would not be the least important. There was a fascination about him which shows that the routine of an architect's life cannot entirely stifle imagination. There were architects no less able in Paris, but somehow their reputation was not widely spread, or they were supposed to be too potent and grave to allow of any familiarity on the part of a stranger. No artist in Paris had on that account to pay a heavier tax than Garnier for the reputation he possessed, and his urbanity in receiving those who considered him to be one of the spectacles of the city could not be surpassed by an American president.

But while so many were ready to appreciate the man, they hesitated about giving commissions to the architect. Charles Garnier found, like architects elsewhere, that the designing of a work which cost 35,000,000 francs was no recommendation to lovers of economy, or, in other words, to the majority of people who contemplate building. The late William Burges used to lament half cynically, half sadly, the want of confidence in him which the wealthy people of Cardiff displayed, in spite of the evidence of genius which all could see at the castle. Numerous as were the new houses and business premises, there was no call on him for a design. The owners were afraid that he would involve them in expenditure on marbles, bronzes, mosaic, and colored sculpture, from which no profit would be derived, and consequently buildings were run up which, if economical, are not beautiful. In the same way Charles Garnier was compelled often to see countless buildings arising which were designed by architects whose reputation did not extend beyond their own arrondissements, while he whose fame was supposed to be world-wide was without a commission in his office, or was merely consulted as a referee. In the latter capacity he too often acted under honorary conditions, especially in connection with projects of the government or the municipality. Garnier was inventive, and he was always glad of an opportunity to talk freely about what was feasible in arranging buildings or fêtes. Once on his hobby, there was no care about fees. His influence could be traced in many of the Paris buildings, although next to his great work the only building of any note in the city which he designed was a club on the Boulevard Saint-Germain.

Yet it was impossible to have a better advertisement of power than was to be found in the Opera House. It is by far the most important of modern French buildings, and rivals the Louvre in suggesting what architecture can do to embellish a city. It is not necessary to pay for admission to the opera in order to appreciate the ability of the architect. The vestibule and staircase which all can see are sufficient. But it may be doubted whether the building will stand the criticism of a later time as well as the Louvre. It was built for an age when costliness was preferred to beauty, and in its excess of ornament, color and gold it expresses the luxury of a period of decadence. For operagoers who care to enjoy music it has not the best auditorium of the Continent, but it was intended for the gratification of the eyes rather than the ears. It is a gorgeous house where there are no shams, for in all that dazzles and fascinates the most expensive materials are employed. The public money was laid out as liberally on the building as in an earlier time it was on the cathedral. The Opera House was a type of modern imperialism; it was generally accepted as such, and consequently, when the group representing Dancing, by Carpeaux, was desecrated by means of a bottle of black stain, everybody concluded that the writing on the wall was visible, and that Bonapartism was at an end. Napoleon III. deserves credit for what was done by Visconti and Lefuel, at the Louvre, but what will be most generally accepted as the memorial of his reign was raised by Charles Garnier.

Bonapartism, as we are repeatedly told by its representatives, is only a consolidation of the forces produced by the first revolution, and therefore is based on equality. The Opera House was to be a palace where the Emperor could meet his subjects without the restraints which tradition prescribed in the Tuileries. Consequently there was only one staircase for grandees and "gods." In a constructive sense that is not a safe arrangement, for the French are as liable to panics as the rest of men, and a couple of years ago, when the gasalier in the house broke down, a catastrophe was very nearly occurring on the staircase. But the common approach was supposed to be as effective an aid to Imperialism as a pamphlet by De la Gerronière or About, although it could not save the doomed system.

In another sense especially the building is a memorial. Many of the Paris improvements were set about with the intention of keeping the working classes quiet by providing them with occupation. The extent to which subsidiary arts are introduced in the Opera House testifies to the same belief in co-operation as a political agency. Charles Garnier's ability is seen in the manner of combining them to produce a harmonious result. He resembled the conductors who were subsequently to officiate within the house, and make a variety of performers subservient to their desires. They could not be successful without acquaintance with the capability of every instrument, and Garnier's employment of sculpture, painting, gilding, reveals the genuine architect, the chief of the artists who controlled because he understood. In most theaters what is ornamental too often suggests something that is applied, and could often be removed without much detriment to the architecture. The busts, masks, symbols, amorini, musical instruments, are as necessary to the completion of the architect's meaning in the Paris Opera House as the larger groups of sculpture. They are not supplementary, but seem to grow out of his original idea and to be inevitable. The manner of employing sculpture is enough to demonstrate how much was gained by Garnier through his early exercises in the art. Notwithstanding the amazing variety which comes from the introduction of so many decorative elements, the whole building impresses one as no more than the realization of a first thought.

In fact, there was so much haste about the earlier stages of the project, there was little time allowed for experiments or alterations. When the site became available through the street improvements, the Emperor appeared to be afraid it would be utilized for a building of a different sort. The competition was hurried. When Garnier was selected, he made a sort of flying visit to foreign theaters before preparing definite plans. But, owing to the expedition employed, in less than nine months after the announcement of the competition the foundations of the building were commenced. In 1861, when so onerous a task was un-

CHARLES GARNIER.

dertaken by Charles Garnier, he was in his thirty-sixth year. His training resembled that of the ordinary Prix de Rome winner. He had traveled in Italy and Greece, had measured and prepared plans for a Temple of Jupiter, and made a series of admirable water-color drawings of ancient buildings in Naples and Salerno, to illustrate a book by the Duc de Luynes, which was never published. Still, he was poor and without patrons. On his return to Paris in his twenty-ninth year he was glad to serve under Ballu in the restoration of the beautiful Tour de Saint-Jacques la Boucherie in the Rue de Rivoli, and finally was admitted among the municipal architects. But he was not favored with opportunities to display constructive skill.

He was not long engaged at the works before his courage was tried. It was necessary to make excavations to a depth of about seventy feet, and in the course of the work springs were tapped which seemed to be inexhaustible. A concrete bed was laid under water, and it was not until toward the close of 1862 that the masonry could be commenced. Garnier had a temporary house and offices fitted up on the site, and there he lived until the works were advanced. Under his constant supervision the construction was carried on, and after seven years the building was ready for roofing. Then the war with Germany commenced and the operations were suspended. The building was not, however, allowed to remain idle. French ingenuity was often exerted on it. The Opera House served as a military store, a hospital, a prison, a barrack, an observatory, etc. It could not be employed for such various purposes without suffering injury, but the wonder is that it was spared from destruction, for it was the most imposing building of the Empire. When peace was restored, Charles Garnier persuaded the government to resume the works, and in January, 1875, the building was opened for performances. St. Paul's Cathedral is not stronger evidence of Wren's toughness in meeting opposition with equanimity, and in overcoming difficulties more annoying than those arising from materials, than is the Paris Opera House for Charles Garnier. Some of the battles he had to engage in are easily inferred by all who have had to encounter officials, whether temporary or permanent, for they are alike all the world over; but whenever the particulars are made known, they will convince Frenchmen of the bravery of the artist they have lost.

His theater at Monte Carlo is on a very small scale if compared with the Paris building. It is, however, almost as characteristic in expressing showiness and lavish expenditure. Charles Garnier was essentially the architect for princes and millionaires who were indifferent to economy. For that reason the bourgeoisie were afraid to trust him. His remarkable series of buildings illustrative of the History of the Habitation, which were set up in the International Exhibition of 1889, served his interest as little as his theaters. Archæologists and architects, of course, did not accept the houses as indisputable examples of ancient dwellings from the days of the troglodytes, and the honest citizens concluded that Charles Garnier was a scenic artist who preferred flimsy construction.

The habitations were, however, a proof of the thorough knowledge of architectural forms which Garnier possessed. Although he never posed as an erudite scholar, he was acquainted with everything that was even remotely related to his art. His books on the Opera House, theaters, habitations and art in general reveal more literary skill than is commonly found with men who do not make a profession of the belles-lettres. He was a capital after-dinner speaker, whose words set the table in a roar, especially when they took the form of verse and were pointed by expressive looks and gestures.—The Architect and Contract Reporter. Engraving from L'Illustration.

THE FLOODS OF THE MISSISSIPPI RIVER AND WATER AS A FACTOR IN AGRICULTURE.

By H. DURANT.

THE floods of the Mississippi River and its tributaries of late years have occasioned great damage, and the danger is increasing each year. The cutting away of the once dense groves of timber has occasioned a more rapid and earlier thawing of snow and ice. When the forests of the north were so dense, the thawing was prolonged until much of the water south had run off. At present it is almost simultaneous.

The United States should have profited by the experience of European and Eastern nations, and guarded against the danger of high water and floods. There should have been but few levees built, more channels should have been opened at or near the mouth of the Mississippi and other large rivers, also, when possible, some distance above. The head waters of all small streams should have one or a succession of dams to restrain the water. By these means only can the country bordering on the lower Mississippi and many of the large rivers that empty into it be saved from ruin. Unless active measures are taken, the destruction of property will be immense and constantly increasing with years. Ditching, tiling, and the bare surface of the earth combined with the rapid thaws that now occur, owing to the clearing away of so much timber, occasion a flow of water that is almost irresistible as it advances south. The tendency will be to increase with years. So it is evident that no levees can retain it.

Owing to the vast amounts of débris carried down by almost all streams, the beds of large rivers for miles above their mouths will fill up and make it a necessity for levees to be constantly made higher, but the filling up must continue until it will be beyond the control of levees. The result is self-evident.

There is a river in China in which the bed is 200 feet above the level of the surrounding country. Of course it will continue to fill up, and must eventually occasion immense destruction. The last serious break drowned three millions of people.

In a dense evergreen forest the ground does not freeze; if at all, but slightly. When the snow thaws, it is largely absorbed by the ground. Land used for agricultural purposes in the Northern States also where timber has been cut off usually freezes to a depth of from 2 to 8 feet; so, when the snow thaws, or it rains in the spring, the water all runs into the streams. Should there be an unusual fall of snow during the winter, a late spring, and when it commences to thaw, heavy rains should occur, no estimate can be made of the damage and suffering the floods would occasion.

How to best guard against such a danger becomes a very important question. Agriculture makes great climatic changes, the clearing of timber from large tracts of land, the pasturing of herds of stock eating up and tramping down vegetation, which allows the direct rays of the sun to fall on the surface of the soil, very much increases evaporation; also underdraining and the smooth surface of cultivated land occasions water to run off much more rapidly than when in a wild state. The sure result is that ponds and small streams, as well as inland lakes, are rapidly disappearing, droughts that are dangerous to agricultural interests are becoming more frequent and destructive. As agricultural interests are paramount to all others and entirely depend on moisture, there certainly is occasion for alarm.

The draining of small lakes and ponds may give a few a farm, but it is at the expense of the whole country, as these lakes and ponds during a dry season would furnish by evaporation and distribute a large amount of moisture over the surrounding country in the form of light showers and dews. The best interests of the country would be promoted if the outlets of all small lakes and ponds were dammed; also on all small streams there should be dams every short distance to retain the water in reservoirs for summer use, and so avoid all danger of droughts.

It is well known to all meteorologists that surface water is surely distributed over the country, and to quite an extent near, by the reservoirs. Precipitation is much more rapidly evaporated from a dry than a wet or moist surface. Owing to this fact, more rain is required, but we have less. So droughts are inevitable, and agricultural interests must suffer. It is quite possible to convert a fertile inland country into a barren desert; islands and coast countries are not so much affected by agriculture. Evaporation and precipitation must keep up an equilibrium, but a cool, moist surface favors precipitation, while a hot, dry surface repels it.

When small streams, lakes, and ponds are abund-

ant, the evaporation from them keeps the atmosphere humid. Vegetation absorbs moisture from the air as well as by the roots. Dews are a great aid to vegetation, and when the atmosphere is moist, are very heavy and aid vegetation very much. Some vegetation exudes moisture, but the amount is small as compared to what is condensed from the atmosphere. With the disappearance of surface water, dews become quite light or cease. Meteorologists are at present making great efforts to ascertain the condition of the upper air currents as regards the moisture they contain. There can be but little doubt that there are moist currents of air over all arid countries, but excessive heat of the surface prevents condensation or precipitation.

From these facts, artificial rain may not be a theory only. The annual spring and fall rains are a fair illustration of a hot and cold surface. The air is constantly full of moisture, but cannot condense over a heated surface. The surface of the ground during spring and fall is quite cool.

Notice the steam from an engine when it meets the cool air; it is plainly seen and condensed, and falls in drops to the ground. If it passed over a red hot surface, it would not be condensed, but dissipated.

The local showers in summer, that are so beneficial to agriculture, usually cover but a small area, as the heated surface dissipates them. There can be no doubt but currents of moist air are passing over the great deserts, but are kept from condensation by the excessive heat of the surface.

Could rain be produced at will, what a revolution it would make! No estimate can be given of the wealth it would add to the world. Solar energy on the ocean is about uniform, evaporation is quite constant, the great body of which is condensed where it is of no use. The ocean evaporation is sufficient to make all the earth a garden.

The care of water and forests should be carefully attended to by the government. The future of a country depends on its retaining its fertility, which depends largely on water and forests. Agricultural interests are of more importance than all others and governments should carefully guard them. A humid atmosphere and a moist surface may not in some respects be as pleasant or healthy as a dry one, but the difference is small and may be in favor of the humid, as the dust storms fill the air with bacteria and microbes and all germs of infectious diseases.

The rapidly increasing population renders it necessary that governments should take every precaution to care for water and forests. The planting of trees is of the greatest importance. It would do much toward retaining and rendering valuable waste tracts of country, even in the Eastern States. It tends to make a country moist and adds to fertility. It also is soon a source of profit, as trees of many varieties grow large enough for lumber in from ten to fifteen years. The benefit of tree planting is more self-evident in the West. Snow drifts are rapidly disappearing, winds are not so violent.

EXPERIMENTS WITH CURRENTS OF HIGH TENSION AND GREAT FREQUENCY.

MR. TESLA, on May 20, 1891, presented to Columbia College the striking results of his very original experi-

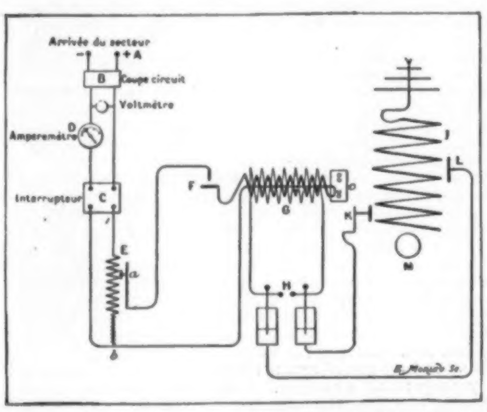


FIG. 1.—DIAGRAM OF THE ARRANGEMENT EMPLOYED FOR M. RADIGUET'S EXPERIMENTS.

A, beginning of the sector; B, circuit breaker; C, bipolar interrupter; D, amperemeter; E, potential reducer; F, vibrator; G, induction coil; H, the D'Arsonval arrangement; K, L, contacts upon the resonator; I, resonator; M, handwheel.

ments with alternating currents of great frequency, and in 1892 came to Paris and repeated his experiments before the Society of Physics and the Society of Electricians. Mr. Tesla pointed out a simple method of producing alternating currents of great frequency based upon the properties of induction coils and condensers. The secondary terminals of a high tension coil are connected with the internal armatures of a Leyden jar which discharges itself disruptively. This disruptive discharge produces alternating currents of great frequency. This process presents a great interest, in that it permits of resuming and completing Tesla's experiments without having recourse to special apparatus that few scientists have at their disposal. The experiments, in fact, have been very numerous, the apparatus have been improved, and new results have been obtained in every direction. We have no intention of speaking of all these experiments and of all these apparatus, and much less of the diverse theories that have been put forth to explain the phenomena. We desire simply to describe the various experiments that M. Radiguet recently performed at the Exposition of the Centennial of the Conservatoire des Arts et Metiers in employing Dr. Oudin's resonators of great frequency. The principle of the production of currents of great frequency is the same as that indicated above. The diagram in Fig. 1 shows the whole arrangement employed. A derived current of 110 volts is taken upon the sector at *A*. This traverses a circuit breaker, *B*, an interrupter, *C*, an amperemeter, *D*, and a potential reducing rheostat, *E*. By means of the wire fixed at *b*, the current passes into the primary circuit of the coil, *G*, traverses a special interrupter, *F*, and returns, at *a*, to a sliding contact capable of moving over the spirals of the rheostat. At the terminals of the secondary circuit of the coil there is, at *H*, the D'Arsonval arrangement for the production of currents of great frequency by means of an arc between the two armatures of a Leyden jar. The two external armatures of the jar are connected with the resonator, *I*. We shall now enter into the details of the various apparatus.

The potential reducing rheostat (Fig. 2) is formed of a German silver wire wound around a frame. This wire is of great length. It will be remarked, also, that in the interior there is a second frame upon which wire is wound. This rheostat is placed directly upon the 110 volt circuit. The intensity that traverses it during the experiments varies from 2 to 12 amperes, and the maximum resistance is 200 ohms. It is, as we have pointed out, by means of collectors at the different points of the resistance that we obtain the difference of potential and the intensity necessary for the operation of the induction coil.

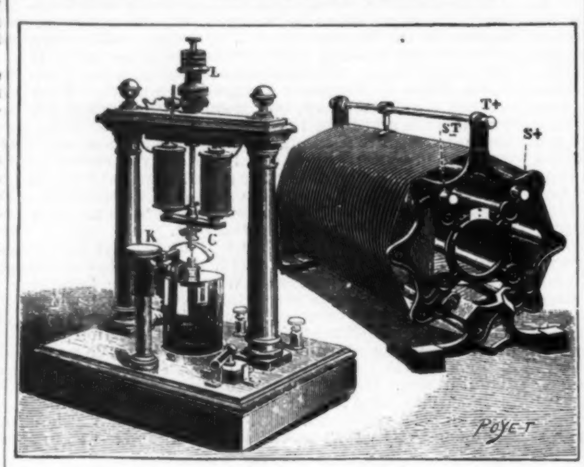


FIG. 2.—VIBRATOR AND RHEOSTAT.

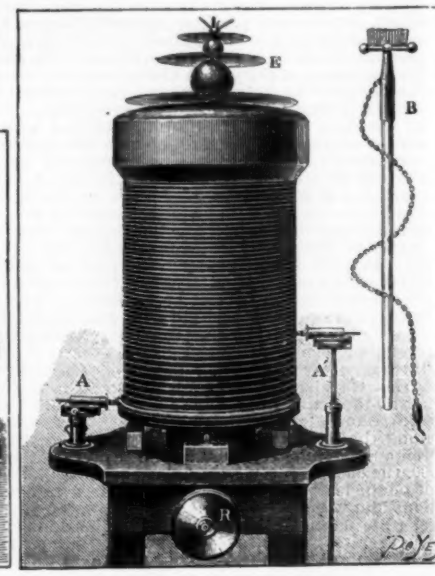


FIG. 3.—THE OUDIN & RADIGUET RESONATOR.

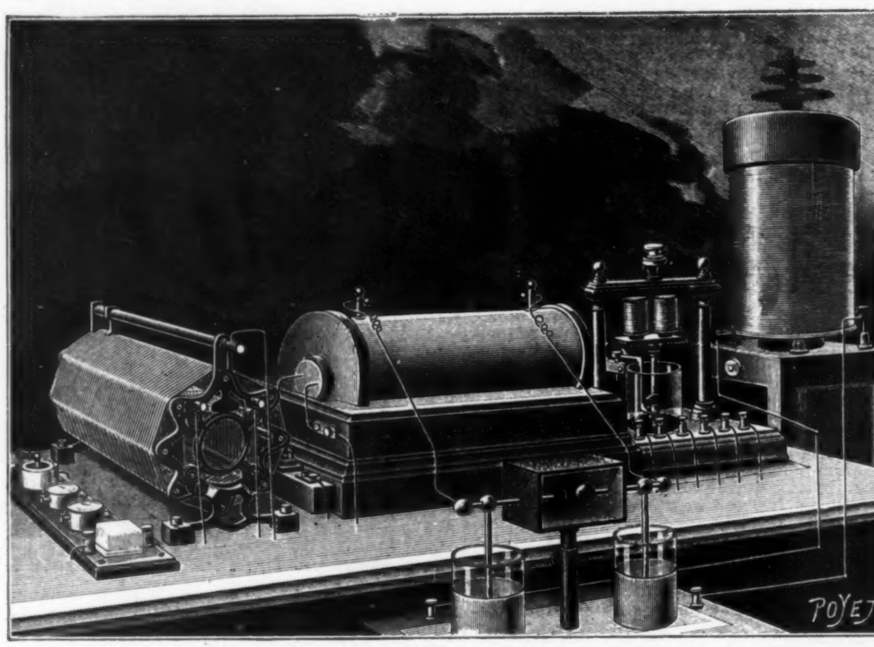


FIG. 4.—GENERAL VIEW OF THE APPARATUS USED IN THE RADIGUET EXPERIMENTS—DISTRIBUTING BOARD, RHEOSTAT, INDUCTION COIL, VIBRATOR, OUDIN'S RESONATOR, AND D'ARSONVAL'S OSCILLATOR.

FIG. 5.—PRINCIPAL EXPERIMENTS MADE WITH THE APPARATUS.

The regulation is very easy, in consequence of the diameter of the wire, which permits of a ready sliding of the external terminal.

The interrupter, *F* (Fig. 2), is formed of a double electromagnet held between two columns. At the center there is a rod which carries a soft iron armature movable in front of the poles of the electromagnets. A screw, *L*, placed at the upper part, permits of regulating the travel of the armature. This latter carries a small copper rod, which rests upon a spring formed of two curved strips of copper, *C*. At the extremity of the spring is placed a slightly conical copper rod.

Beneath the latter there is arranged a block of copper held upon the side by a curved rod with a micrometer screw, *K*, that permits of displacing the block at will. It is between the conical rod and the block of copper that appears the rupture arc, which is analogous to the voltaic. In order to prevent rapid deterioration, the contacts are immersed in kerosene contained in the vessel that may be seen in the figure. It is thus possible to regulate the contacts very easily by acting upon the travel of the armature and the block of copper. This interrupter operates very rapidly and answers very well for great frequencies.

At *G* is the induction coil, which gives 22 inch sparks, and which is mounted in a bath of paraffine, which insulates the lower parts of the condensers. At *c*, upon the side, are the collectors for the condensers of variable capacity, permitting of causing the effects to vary.

Afterward, at *H*, we find the D'Arsonval arrangement for the production of alternating currents of great frequency. The extremities of the induced wire of the induction coil are connected with the internal armatures of a Leyden jar. The external armatures are connected with the Oudin resonator, *I*.

Dr. Oudin, as long ago as 1892, showed that it was possible to obtain currents of very high tension by employing a sort of resonator formed of a solenoid composed of several spirals of coarse wire of feeble resistance. The extremities of this wire are connected with the terminals of a source of currents of great frequency. Such a result is obtained only for certain determinate values of capacity and of self-induction of the solenoid. A general view of the apparatus used for such experiments is given in Fig. 4.

M. Radiguet, from instructions given by Dr. Oudin, has constructed a new resonator (Fig. 3) formed of a solenoid of noninsulated copper wire surrounding a cylinder of paraffined wood. The wire is $\frac{1}{10}$ inch in diameter and 195 feet in length, and the spacing of the spirals is $\frac{1}{5}$ inch. One of the external armatures in the D'Arsonval arrangement is connected directly with a sliding contact, *A*, at the extremity of the solenoid. The other ends at a contact, *A'*, placed upon the side at a higher level. The contacts are fixed and the solenoid is movable around a vertical axis. It may be displaced by means of a tangent screw, through a handwheel, *R*, so as to increase or diminish the number of the spirals in each of the parts of the solenoid. The resonator is thus divided into two parts. At the lower part are produced the oscillations of great frequency and at the upper part are found the currents of great frequency and of very high tension.

This apparatus, which Dr. Oudin studied with a purely therapeutic object in view, has been ably put to profit by Mr. Radiguet in the performance of the most curious and suggestive experiments, some of which are represented in Fig. 5. After the apparatus has been thoroughly regulated, we may, upon placing the hand near it, see violet aigrettes from 6 to 8 inches in length make their appearance. The resonator creates all around it, from top to bottom within a circle of 6½ feet radius, a very intense alternating electrostatic field, and it is possible, by simply holding them in the hand, to render a number of Geissler or Crookes tubes luminous. The number of the experiments may be varied to infinity. We may mention in particular those of the umbrella and the cord shown in our figure. If a wire be attached to the upper part of the resonator and be made to revolve, we shall perceive a luminous cord whence shoots a series of violet aigrettes; so, too, if an umbrella be placed in the field, we shall see all the ribs become luminous.

This is only the beginning of the applications of this apparatus; but who can say where we shall stop, now that it is possible easily to create a powerful and quite extensive electrostatic field? In a short time dancers will appear upon the stage of the theater carrying objects that will be luminous without being connected with any source. The success obtained by M. Radiguet at the Exposition of the Centennial of the Conservatoire des Arts et Metiers is a sure guarantee to us that his experiments greatly interested the scientific world and the public.

For the above particulars and the illustrations we are indebted to La Nature.

UNDERGROUND ROAD FOR PARIS.

PLANS are being perfected for operating 2½ miles of the Orleans Railroad, of France, by electric locomotives, over an extension of the line from the present terminal at Valhubert Station, through a subway to the Quai d'Orsay, in the heart of the city. From Place Valhubert the line will drop on a grade of 1·1 per cent. for 440 meters. For 900 meters the construction will be a masonry arch of 9 meters span, giving room for double tracks. For 500 meters along the bank of the Seine the subway will consist of a metal roof supported by masonry walls, the lack of support on the river side and the small depth of the construction not admitting of a masonry arch. For the balance of the distance there will be a masonry arch of 8 meters span. There will be one station between the Orsay and Valhubert stations, which will be at Place St. Michel. The Orsay station will have 15 tracks to accommodate arriving and departing trains. The platforms at the St. Michel station will be 230 meters long and those at Orsay 185 to 240 meters long and 6 to 7 meters wide. The underground portion of the road will be nearly level, with the rail 25 feet below the street. There will be 8 locomotives, using continuous current from a third rail, at a pressure somewhere between 500 and 700 volts. A party of engineers from the Orleans Company recently visited this country, examining the systems of heavy traction at Hoboken, Baltimore, Chicago, Schenectady, Nantasket Beach, and Berlin, with which Americans are familiar. The Paris enterprise will involve an expenditure of $8,000,000.

ANCIENT ORGANS.*

THE hydraulic organ filled with its powerful voice the vast arenas in which the gladiators fought, and Petronius relates that Nero one day made a vow to play one of them himself in public if he escaped a danger that threatened him. The invention of them is attributed to Ctesibius.

Fig. 1 gives a reproduction of one of these instruments as described by Heron in his "Pneumatics."

Let *B Δ* be an altar† of bronze containing water. Let there be in the latter an inverted hollow hemisphere, *E Z H* (called a damper), that allows the water to pass all around its bottom, and from the top of which rise two tubes that communicate with the interior. One of these tubes, *H K*, is bent in the interior and communicates with a small inverted box,‡ *N Π*,

FIG. 1.—HYDRAULIC ORGAN.

the aperture of which is at the bottom, and the interior of which is bored out so that it may receive a piston, *P I*, which should fit very accurately so as to allow no air to pass. To this piston is fixed a very strong rod, *T γ*, with which is connected another rod, *γ Φ*, movable around a pin at *γ*.§ This lever moves upon a fixed vertical rod, *Ψ X*. Upon the bottom of the box, *N Π*, is placed another box, *Ω*, which communicates with the first, and which is closed at the upper part by a cover that contains an aperture to allow of the passage of the air into the box, *N Π*. Under the aperture of this cover, and in order to close it, there is arranged a thin disk, held by means of four pins, which pass through apertures in the disk, and are provided with heads in order to hold it in place. This disk is called a platysmatim (Fig. 2). The other tube, *Z Z*, is carried by the hemisphere, *E Z H*, and ends in a transverse tube, *A A'*,‖ upon which rest pipes communicating with it and having at their extremities glossocomiums¶ that communicate with these pipes, and the orifices, *B'*, of which are open. Across these orifices, covers provided with holes,** slide in such a way that when they are pushed toward the interior of the organ their holes correspond to the orifices of the pipes (and to those of the tube, *A A'*), and that when they are pulled back, the pipes are closed, since there is no longer any correspondence.

If, now, the transverse rod, *γ Φ*, be lowered at *Φ*,

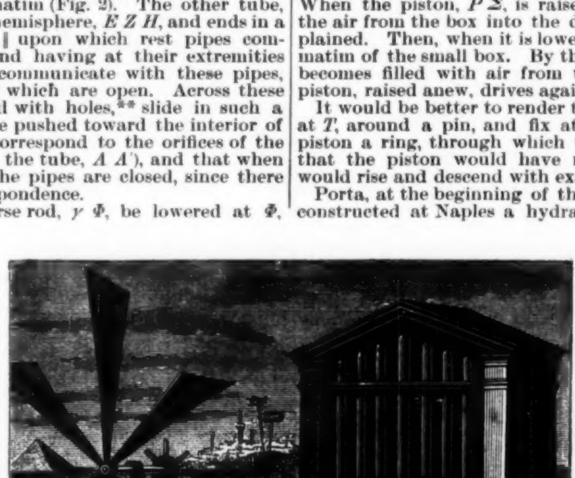
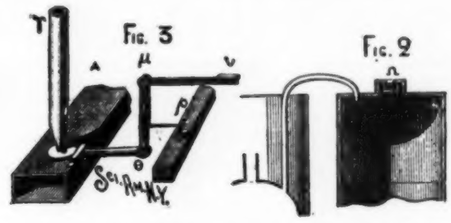


FIG. 4.—WINDMILL ACTUATING THE BELLOWS OF AN ORGAN.

the piston, *P Σ*, will rise and compress the air in the box, *N Σ O Π*, and such air will close the aperture of the small box through the intermedium of the platysmatim described above. It will then pass into *E Z H* by means of the tube, *K H*, then into the transverse tube, *A A'*, through the tube, *Z Z*, and finally from the transverse tube into the pipes, if the orifices correspond to those of the covers, and this will occur when all the covers (or only a few of them) have been pushed toward the interior.

In order that their orifices may be open when it is desired to make certain pipes resound, and that they may be closed when it is desired to cause the sound to cease, the following arrangement is employed: Let us consider isolatedly one of the mouths placed at the extremity (Fig. 3). Let *γ δ* be this mouth, *δ* its orifice, *A A'* the transverse tube, and *σ* the cover that is adapted and the aperture of which does not coincide with the apertures of the pipes at this moment. Let us now suppose a jointed arrangement composed of three rods, *δ*, *μ*, and *ν*, the rod, *ε δ*, being attached to the cover, *σ*, and the system as a whole moving around a pin, *μ*. It will be seen that if we lower with the hand the extremity, *ν*, of the system toward the orifice of the glossocomiums, we shall cause the cover to move toward the interior, and that, when it arrives there, its orifice will coincide with the orifices of the pipes. In order that, upon removing the hand, the cover may be carried back toward the exterior and close all communication, an arrangement such as the following may be employed. Beneath a number of glossocomiums there is established a bar equal in length to and parallel with the tube, *A A'*, and to which are fixed strong curved plates of horn, such as *γ*, placed opposite *γ δ*. A cord is fixed to the end of this plate and winds around the extremity, *δ*, in such a way that when the cover is moved toward the exterior the cord shall be taut. If the extremity, *ν*, then be lowered, and the register be thus pushed into the interior, the cord will draw upon the horn plate,



FIGS. 2 AND 3.—DETAILS OF THE HYDRAULIC ORGAN SHOWN IN FIG. 1.

and by its force, right it. But as soon as the pressure ceases, the plate will resume its former position and draw the cover back in such a way as to prevent its orifice from establishing a communication. This arrangement being adopted for all the glossocomiums, it will be seen that in order to cause any one of the pipes to resound, it will suffice to depress the corresponding key with the finger. When, on the contrary, it is desired to cause the sound to cease, we shall merely have to lift the finger, and the effect will be produced by the motion of the cover.

Water is poured into the small altar in order that the compressed air that is driven from the box, *N Π*, may, owing to the pressure of the liquid, be retained in the damper, *E Z H*, and thus supply the pipes. When the piston, *P Σ*, is raised, it, therefore, expels the air from the box into the damper, as has been explained. Then, when it is lowered, it opens the platysmatim of the small box. By this means the box, *N Π*, becomes filled with air from the exterior, which the piston, raised anew, drives again into the damper.

It would be better to render the rod, *T γ*, immovable at *T*, around a pin, and fix at the bottom, *P*, of the piston a ring, through which this pin would pass, so that the piston would have no lateral motion, but would rise and descend with exact perpendicularity.

Porta, at the beginning of the seventeenth century, constructed at Naples a hydraulic organ according to the arrangement just described. A few years afterward, in 1645, Father Kircher constructed another at Rome for Pope Innocent X. These organs had the defect of not preserving the note, but of giving a series of harmonies. On the other hand, they produced an exceedingly agreeable tremolo. It was probably these unusual variations in sound that charmed the ears of the Greeks and Romans.

Heron afterward describes a bellows organ, motion to which is communicated, not by manual power, but by a windmill. Fig. 4 shows the arrangement with suffi-

* Copyrighted, 1897, by Munn & Company.—From "Magic: Stage Illusions and Scientific Diversions, including Trick Photography."

† Altars were cylindrical or square pedestals, characterized by a cavity in the upper platform, in which a fire was lighted.

‡ This box performs here the office of a pump chamber.

§ The figure shows another arrangement.

‖ Called a wind-chest in modern organs.

¶ Flute mouths.

** Registers.

cient clearness to permit us to dispense with a description. It is interesting to reproduce, in that it carries the origin of windmills (which it is claimed were unknown to antiquity, because Vitruvius and Varro do not speak of them) back, at least, to the second century before our era.

STATEMENT OF THE RESULTS OF THE OFFICIAL TRIALS OF THE THREE SECOND-CLASS DUTCH CRUISERS "HOLLAND," "FRIESLAND," AND "ZEELAND," WITH YARROW WATER TUBE BOILERS.

SHIP, 306 feet by 48½ feet by 17 feet 9 inches depth.
Displacement, 3,900 tons, with 400 tons of coal.
Total coal supply, 850 tons.
Engines: Two—33 inches, 49 inches, 74 inches, by 39 inches.

for cold and hot air (Sturtevant's) evaporators, feed water filters, etc.

The "Friesland" has been built and engined by the "Maatschappij voor Scheeps en Werktuigbouw Fijenoord" at Rotterdam (Director Croll); the "Zeeland" by the "Koninklijke Maatschappij de Schelde" at Flushing (Director van Raalte); and the "Holland" has been built by the Royal Dockyard, at Amsterdam, and engined by the "Nederlandsche Fabriek van Werktuigen en Spoorweg Materieel" at Amsterdam (Director Strumphler).

The "Friesland" made all the trial trips between October 18 and November 3.

The total weight of propelling engines and boilers, also water, pumps, and fans, funnels, floor plates, ladders, in fact, everything which can be brought under the propelling engines, is—for "Holland," 635 tons; for "Friesland," 611 tons; for "Zeeland," 570 tons.

The results are as follows:

Date.	Speed.	Rev.	I. H. P.	Air Pressure in Water. Height.	Number of Boilers.	Coal Consumption per I.H.P. Lb. per Hour.	Time. Hours.	Remarks.
"FRIESLAND."								
October 18, 1897....	10·423	71·6	1,077	....	3 W.T.*	....	4	No auxiliary engines included in the coal consumption.
October 19, 1897 ...	12·528	87·25	2,006	......	4 "	1·84	6	
October 20, 1897....	17·275	124·2	5,982	0·4"	All 10.	1·62	4	
November 3, 1897...	19·87	147·27	10,416	0·8" to 1·6"	"	1·67	4	
November 3, 1897...	Max.	148·3	10,850	"	"	....	......	
"ZEELAND."								
December 28, 1897..	10·24	64·2	1,162	....	3 W.T.	....	4	Propellers at 17½ feet.
December 29, 1897..	12·4	78·6	2,062	....	4 "	....	6	
April 5, 1898	19·47	138·58	9,818	1·2" to 2"	All 10.	2·06	4	All auxiliary engines included in the coal consumption.
April 5, 1898	Max.	141·5	10,589	"	"	.... ..	......	
April 6, 1898	16·466	114·22	5,203	0·4"	"	2·1	4	Propellers at 16 feet.
No feed heater was fitted in this case.								
"HOLLAND."								
February 6, 1898...	9·973	70·04	1,216	. ...	3 W.T.	....	4	All auxiliary engines included in the coal consumption. Ship had been docked last February 4, 1898.
February 9, 1898...	11·63	80·51	1,778	....	4 "	....	6	
February 24, 1898...	16·92	123	6,236	0·4"	All 10.	....	4	
May 10, 1898	19·618	145·86	10,548	0·8" to 2"	"	2·28	4	
....	Max.	149·6	11,712	....	"	....	......	

General Remarks.—The Ind. H. P. is the I. H. P. of the chief engines only. The stokers on board "Zeeland" and "Holland" had not been so well trained as on board the "Friesland."

* W. T. means water tube boilers.

Propellers, 14 feet by 16 feet and 60 square feet surface.

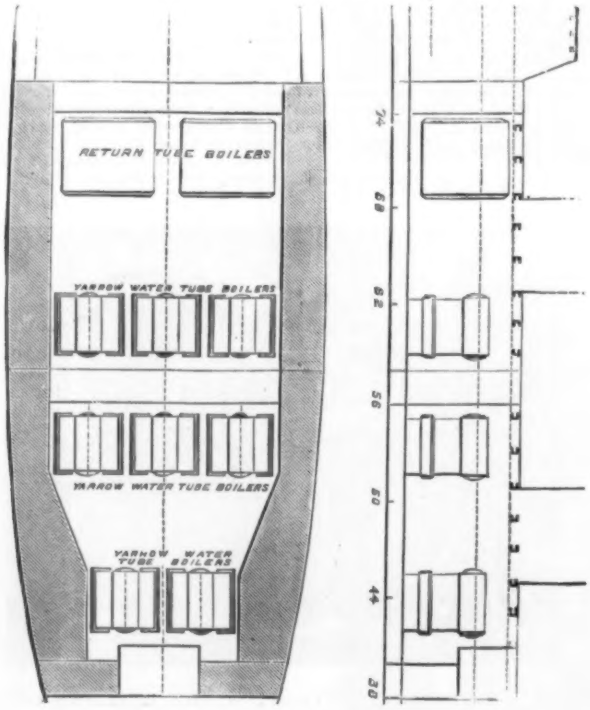
Boilers, two cylindrical. Grate surface equals 126 square feet. Heating surface equals 4,005 square feet. Eight Yarrow water tubes. Grate surface equals 322 square feet. Heating surface equals 16,136 square feet. Messrs. Yarrow's firm made one boiler for each of the ships and Dutch firms made the other seven for each of the ships.

The propellers of the "Holland" turn to the outside; the propellers of the "Friesland" and "Zeeland" turn to the inside.

The total maximum horse power for which the boilers were designed was 9,250; 2,250 horse power being obtained from the two return tube boilers and 7,000 horse power from eight Yarrow water tube boilers, the weight of the two return tube boilers being, with water, 120 tons, and that of the eight Yarrow boilers, with water, 88 tons.

The object of the Dutch authorities in adopting the combination of return tube and water tube boilers was to gradually accustom the stokers to the latter form of boiler.

In the three similar cruisers building in Holland,



Steam pressure in both types of boilers, 200 pounds per square inch.

The "Holland" and "Friesland" have Weir's feed pumps and feed heaters.

"Zeeland" has Yarrow's automatic feeding arrangement, with a Worthington pump to each water tube boiler. No feed heaters.

There are steam steering engines, dynamos for electric light and for search lights, torpedo air pumps, steam capstans, refrigerator engines, steam ventilators

which are to be launched very shortly, twelve Yarrow boilers are being fitted instead of the two types of boilers.

Comparing the results obtained in the three Dutch cruisers with that obtained in the "Diadem," which may be taken as the most improved cruiser in Her Majesty's navy, we find, taking the mean weight of the machinery in the three Dutch cruisers at 605 tons, and the mean full speed horse power at 10,260, that 16·9 horse power is obtained to the ton weight of machinery; while, taking the weight of the "Diadem" machinery at 1,437 tons and the horse power at 17,262 (taken from Sir John Durston's paper read at the Naval Architects' meetings), we find that 12·01 horse power is obtained to the ton weight of machinery. On the other hand, it must be borne in mind that the "Diadem's" full speed trial was for six hours, while in the Dutch cruisers it was for four hours. These results cannot fail to prove the wisdom of the course adopted by the Dutch authorities, who, on this occasion, seem to have taken the lead of other naval powers.

ACETYLENE BURNERS.

ONE of the most pronounced defects of the ordinary acetylene burner is its liability to become quickly foul through the deposits of carbon that form in it.

Many methods have been proposed for remedying this state of things, and, among others, that of adding air or inert gases to the acetylene. Such mixtures per-

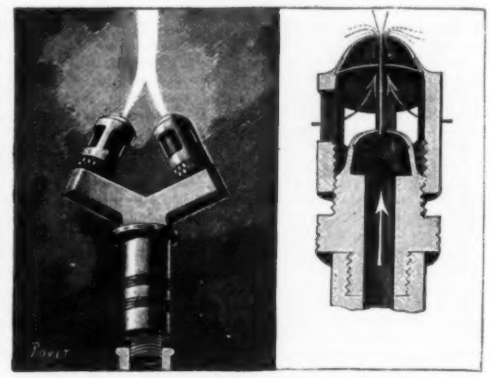


FIG. 1.—THE LETANG & SERPOLLET ACETYLENE BURNER.

1, general view; 2, details of one of the branches.

mit of giving the burner a larger section, without increasing the consumption of the acetylene. It results also that the gas slightly cools the orifice, and that we thus avoid the chemical actions that tend to convert the gas into polymerous carbides. A few results have already been obtained, but they are of little consequence.

MM. Letang and Serpollet have just devised a new arrangement which may lead to still further improvements. The apparatus (Fig. 1, No. 1) is formed of a threaded cylinder, which is screwed to the tube of the lamp. At the upper part of this there are two branches which make nearly a right angle with each other. Upon each of these branches there is mounted a conical nozzle, of which the details are shown in No. 2 of Fig. 1. This nozzle, at its extremity, is provided with a narrow orifice through which the gas escapes. It is covered with a hollow cap, which is mounted through a screw, and the bottom of which contains an orifice ten times wider than the one in the nozzle. This arrangement keeps the flame at some distance from the

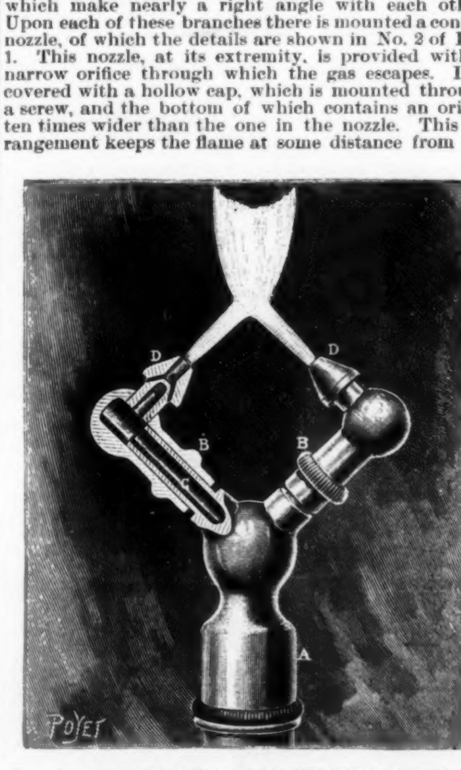


FIG. 2.—THE MARBEC ACETYLENE BURNER.

nozzle, so that it can neither heat nor foul it. Moreover, all around the cap there is a series of apertures that permit of a free circulation of the air. It must be remarked, too, that the gas which escapes from the nozzle passes through a closed cavity, carries along the air found therein, and creates a certain degree of vacuum. The external air therefore at once enters, passes over the edges of the orifice and becomes mixed with the gas.

The convergence of the two inclined jets and the double current of air diminish the amount of fouling to a very great degree. Photometric measurements have shown, it is said, that the discharge is 445 cubic inches per carcel-hour.

We may mention likewise a burner constructed by M. Marbec, of Aix, and which is represented in Fig. 2. This burner is formed of two branches that are slightly inclined, so that the two flames unite with each other. It consists of a base, A, carrying two tubes, into which are inserted the parts, C, to which are fixed the burners properly so called, which are of steatite, glass, metal,

or other material. As shown by the section, there is placed above the orifice a cap of which the orifice widens outwardly. At the same time, upon the sides, there are draught holes to permit of the entrance of air from the exterior. Owing to such arrangements, it is possible easily to regulate by hand the direction and spacing of the two jets. The latter can be made to approach or recede according to the discharge of the burners. It is likewise possible always to direct the jets in such a way that they shall properly combine. This operation may be performed during the lighting. MM. Thuillier and Aubry, of Nogent-en-Bassigny, have recently sent us another model, which likewise is formed of two inclined branches. At a certain distance from the opposite orifices there are on each side diaphragms containing orifices sufficiently wide to allow the gas alone to escape. The orifices are therefore never in contact with the gas and the products of combustion; nor can the burner be raised to a temperature high enough to decompose the acetylene. For the above particulars and the engravings we are indebted to La Nature.

[Continued from SUPPLEMENT, No. 1183, page 18974.]

GLACIAL GEOLOGY IN AMERICA.*

By HERMAN L. FAIRCHILD.

GLACIAL PERIOD.

CAUSE.—The cause of the glacial period remains quite as much a mystery as it was in 1840. A large body of fact has been collected, but it points in different directions. Every person has entire liberty of opinion. Most glacialists have no opinion at all upon this subject. Up to 1875 the Lyellian hypothesis of land elevation as the cause of the cold climate and snow accumulation had the majority of adherents. In America this was proposed by C. B. Adams in 1850, and was adopted by Dana in his presidential address of 1855 and was held by him during his life. It has been the consistent teaching of the Manual of Geology. Of preglacial elevation of northern land there is little doubt, but many glacialists find reasons for thinking that during the latter part of the glacial period the land was lower than at present, and certainly was so at the close.

Croll's "Climate and Time" presented a plausible astronomical hypothesis, the concurrence of variable elements in the relation of the earth to the sun affecting alternately the north and south polar regions. For a time this won large assent; but objections soon multiplied. The secular periods of glaciation apparently required by this hypothesis in preceding geologic time are quite lacking, although glacial drift deposits occur as far back as the Permian. The most serious objection is the absence of glaciation over vast areas of Arctic lands, as Alaska and Siberia. Even the physical competency of the astronomic changes has been questioned, and the hypothesis has fallen into neglect, as the tendency of late is to concentrate attention on phenomena and more immediate inferences.

A change in the axis of the earth is a suggestion that finds few supporters. An hypothesis of atmospheric change, a variation in the amount of the carbon-dioxide content of the atmosphere, has recently received the support of Prof. Chamberlin.

The opinion of the majority of geologists may probably be fairly stated by saying that the various elements affecting climate, geographic, atmospheric, and astronomic, are thought to be so nicely balanced that a comparatively slight change or maladjustment may produce serious climatic effects.

Time Divisions.—Prof. Dana in 1855 proposed the tripartite division of the glacial period, correlating with land oscillation, into (1) the Glacial epoch with high elevation of land; (2) the Laurentian (Champlain), with depression of the land; and (3) a transition epoch, called the Terrace, during which the land rose to its present level and the river terraces were cut by the enlivened streams. This scheme was elaborated in the first edition of his Manual, in 1862, and adhered to with slight changes in all subsequent editions. In the 1879 edition he gave the Terrace epoch a formal place, changing the name in the last edition to "Recent." The name "Champlain," originally given to the marine clays by Edward Hitchcock, was substituted for "Laurentian" in the edition of 1867.

While this terminology has been generally used and the time divisions adopted in a general way, some modifications have been thought desirable. It is believed by many that the Champlain subsidence was far along, perhaps at its maximum, before the ice sheet retreated. Indeed, Mr. Upham would make the Champlain only the closing part of the Glacial epoch. The "Recent" epoch is now regarded as essentially a part of the present epoch, and this view is strengthened by the demonstration, by Mr. Gilbert, that the northward differential uplift of at least the Laurentian basin is still in progress.

Interglacial Epochs.—Dana held firmly to the essential unity of the Glacial epoch, and in this he was largely followed, especially by the men who were trained upon the comparatively simple, homogeneous drift sheet of the Eastern States. But in the broad areas of the West the drift is not so simple. Early in the study of the region buried soils, peat beds and other evidences of deglaciation were found intercalated in the drift, and were noted by Whittlesey, Newberry, Orton, N. H. Winchell, and others. In 1873 Newberry regarded the "Forest Bed" as marking a distinct deglacial condition in the drift period. In 1878 McGee described vegetable deposits in the drift of northeastern Iowa of such depth and areal extent as to indicate an interglacial epoch, and he discriminated a later from an earlier till. Subsequently Chamberlin accepted these conclusions, and in 1882 he discovered the greater southern extension of the older drift and noted the evidences of a long interval between. This idea of the duality or multiplicity of the glacial epochs met with long continued opposition, but was found by the glacialists of the West a good working hypothesis, and evidences in its favor have multiplied.

In 1889 Chamberlin regarded the fringe in Pennsylvania as the unburied edge of the older drift, and in 1891 Salisbury described the extra morainic drift of New Jersey and Pennsylvania as the weathered and eroded border of a drift sheet far older than the moraine-bordered till. This was the first recognition in the Eastern States of multiple drift phenomena comparable to that in the Western States.

The study was given definiteness and placed on a working basis by the admirable article of Prof. Salisbury, in 1893, on the "Criteria for recognition of distinct glacial epochs." The application of these criteria by different workers, particularly Leverett, Coleman, and Hershey, has so strongly confirmed the view of distinct ice invasions separated by intervals of deglaciation that this has passed quite beyond the point of argumentation, and the question now is as to the extent and duration of the stages of deglaciation, or the relative length and importance of the glacial and interglacial time divisions.

In 1894 Prof. Chamberlin presented the whole matter, in condensed form, in Geikie's "The Great Ice Age," and set the example, subsequently followed by Geikie, of denoting the several glacial time divisions by geographic names, using the names of areas where the individual deposits are typical. In 1895 he gave similar names to the interglacial epochs. The contemporaneity in Europe and America of the climatic oscillations and of the epeirogenic movements, at least in a general way, seems quite demonstrated by the studies of Chamberlin and Geikie.

Time Subsequent.—A question of great popular interest concerning glaciation is that of time—the time in years, especially since the ice disappeared. Glacialists will in honesty have to admit that they cannot yet fully satisfy that proper curiosity. That the time is very brief, judged by geologic time standards, since the ice sheet finally disappeared from our region seems certain. Judging from the freshness of the glacial scorings and the deposits, 5,000 or 10,000 or 15,000 years is thought by many glacialists to be a fair estimate of the length of their exposure. But no reliable chronometer has yet been found. Niagara gorge has been regarded as the best timepiece, but fuller study has made the "Niagara Problem" more complex and uncertain. It seems likely that the volume of Niagara's water has varied greatly for long periods, as the history of the river is intimately connected with that of the glacial lakes of the upper lake basins. It is admitted that during the ice retreat the Laurentian basin was lower, as regards sea level, than at present; and was progressively lower northward and northeastward. It also seems certain that at the time of the ice removal the waters found lower outlets eastward from Lake Huron than by way of Lake Erie, and that such outflow persisted until the slow differential uplift raised the northern outlet above the St. Clair outlet. Hence for one, or probably two, long stages Niagara River carried only the insignificant drainage of the Erie basin. This argues for greater length of postglacial time. On the other hand, there is a question as to the origin of the gorge, whether cut de novo, or in part re-excavated or enlarged by the modern river. The chief students of the subject have been Gilbert, Spencer, Upham, and Taylor. Out of the mass of literature two papers must be noticed: that of Gilbert, "The History of Niagara River," 1890, which placed the elements of the problem before the public; and the paper by F. B. Taylor, 1898, "Origin of the Gorge of the Whirlpool Rapids at Niagara," which gives the latest results of the correlation study of Niagara and the glacial lakes.

The recession of St. Anthony's Falls in the Mississippi has also been studied as a measuring rod of postglacial time, especially by N. H. Winchell, with results concordant with those of Niagara and other similar studies.

Recently Mr. H. M. Bannister has argued for great duration of the ice sheet, from data derived from transportation of far-traveled erratics; and Mr. Taylor finds a great length of time required to form the moraines of recession, in the Erie-Huron basin laid down by the slow oscillations of the ice-front; the latter paper favoring astronomical forces as a cause of glaciation, at least in part.

The question of glacial time is closely connected with the problem of glacial cause.

INTERPRETATION OF SPECIAL PHENOMENA.

Drumlins.—These are usually conspicuous topographic features, and frequent references to them, under various descriptive terms, occur in the early literature of the drift. Under the diluvial hypothesis little effort was made to explain their origin, and Edward Hitchcock found in them an objection to the glacial theory.

The name "drumlin" was applied in 1866 to similar drift masses in Ireland by H. M. Close. In America various appellations were given: by Prof. Shaler, who was the first American to write upon them, "drums" and "sow-backs," 1870; by C. H. Hitchcock, "lenticular hills," 1876. The elongated forms of Central New York were described in 1882 by Laurence Johnson as "parallel drift hills," and Prof. Chamberlin in 1883 called them "mammillary" or "elliptical hills." The name drumlin was proposed for use in this country by W. M. Davis, in 1884, and at once adopted.

As nearly all drumlins are composed wholly of till, and especially so in the superficial part, it was early recognized that they were an immediate product of ice work, and they were so referred by Close, as early as 1864. In 1872 Kinahan and Close regarded them as subglacial and constructive, comparing them to the longitudinal sand bars in the bed of a stream. This view of the genesis of drumlins has been adopted, in a general way, by most American glacialists. The suggestion made by Prof. Shaler in 1870, that they may be remnants of an earlier, eroded drift sheet, or that they represent old moraines remodeled by readvance of ice, as proposed by C. H. Hitchcock, have been quite abandoned. Their parallelism with the direction of ice movement was first noted in America by Hitchcock and Upham in 1875. In 1883 Prof. Chamberlin discriminated drumlins from moraines, as being longitudinal, or axi-radiant with reference to the moving ice body.

The hypothesis of drumlin origin by the piling of the ground moraine by differential pressure and movement of the overriding ice body, along the peripheral zone where transporting power becomes inadequate to the drift burden, is regarded as a plausible and satisfactory explanation. The chief objection to this is negative, the failure of more uniform distribution, and even the entire absence of drumlins over vast areas of drift. Another difficulty is physical: A lack of precise knowledge of the manner in which ground moraine is lifted in relatively short distances to heights of 100 or 200 feet. Mr. Upham has attempted to solve this problem by an argument for the construction of drumlins, and moraines also, by the lodgment of englacial drift. This difficulty is less acute, however, since Prof. Chamberlin had observed sections of miniature drumlins beneath the ice foot of the Greenland glaciers, with the overriding ice moulding itself to the drumlinoid curve.

Moraines.—The masses of moraine drift were not entirely overlooked in early writings upon the diluvial phenomena, yet they were not emphasized, since their superior importance and interest only appear with their recognition as marginal phenomena of the ice sheet. On account of their irregular topography and areal distribution, they are not so likely to attract attention as drumlins or even as some eskers, and not until the glacier theory was so established as to be made the basis of observation and investigation were moraines discriminated and mapped. Their systematic study is within the last twenty-five years.

The eariest mention of moraines by that name in American geology is believed to occur in the postscript to Edward Hitchcock's Geology of Massachusetts. Appreciating their significance as glacial phenomena, he gives a large space to moraines and notes their occurrence at various localities. The closing paragraph is as follows:

"Is it possible that the whole of Cape Cod is nothing but a vast terminal moraine, produced by a glacier advancing through Massachusetts Bay and scooping out the materials that now form the Cape? In this case, the moraines at Plymouth and Truro would form part of the lateral moraines, and probably most of Nantucket and Martha's Vineyard might be regarded as moraines of the same glacier, when it extended further south."

The hills of the Long Island moraine were described by Mather, in 1843, in his report on the First New York District, but without recognizing their true character.

In his chapter on surface geology, in the report on the geological survey of Canada, for 1863, Robert Bell described ridges of drift as resembling moraines, along the Ottawa River, which was a correct diagnosis. His map of superficial deposits, accompanying that report, is believed to be the first map of Pleistocene deposits published in America with recognition of glacial agency.

In 1864 J. D. Whitney published a notice of terminal moraines of Alpine glaciers in the Sierra Nevada, about Mount Lyell and Mount Dana. In 1866 Whittlesey indicated on his map, in the Smithsonian Contributions, "morainic knolls" south of Lake Erie, also west of Lake Michigan, the latter being the noted "kettle range," studied later by Chamberlin; but apparently he did not understand their significance as terminal drift.

In his report of the Iowa Geological Survey, 1870, Dr. C. A. White refers certain ridges, somewhat hesitatingly, to terminal moraines. Excluding the references by Edward Hitchcock, this is probably the earliest notice printed in the United States of terminal moraines in the open country, as distinguished from those of Alpine glaciers in the mountain valleys.

In 1871 Mr. Gilbert described the series of recessional moraines in the Maumee Valley; and from this time the study of morainal drift was prosecuted with more confidence.

Probably the earliest positive recognition of the great terminal moraine of the continental ice sheet was made by C. H. Hitchcock, in a paper on the Long Island moraine, read before the New York Lyceum of Natural History, in 1868, but never printed. Several years passed before there were any published descriptions of the terminal moraine, and it is interesting to note the comparative suddenness and contemporaneity with which several workers covered the entire line of terminal drift from Cape Cod to the Missouri. In 1875 G. M. Dawson recognized the "Missouri Coteau" as marginal glacial debris. In 1877 T. C. Chamberlin described the Wisconsin kettle moraine and indicated the southern limit of drift from Nebraska to New York. This was the first definite mapping of moraines in American geology. In the same year George H. Cook and John C. Smock published their first paper on the terminal moraine crossing New Jersey, and in 1878 and 1879 Warren Upham published descriptions of the terminal moraine series which he had surveyed from Staten Island to Cape Cod. In 1881 H. Carvill Lewis and G. F. Wright traced the same drift series across Pennsylvania, the results being printed in 1884. Prof. Chamberlin's classic paper on the "Terminal Moraine of the Second Glacial Epoch," which has been a basal reference for all subsequent work upon the moraines about the great lakes, was published in 1883. It will be seen that within six years, 1877 to 1883, the important terminal and recessional moraines within the limits of the United States were located and described; and although the work in preparation for publication, especially by Prof. Chamberlin, must have occupied some years preceding, it is nevertheless a good example of the saltant character of intellectual progress.

In 1878 Prof. Chamberlin correlated the Cape Cod-Long Island morainal series with the "Kettle Moraine" belt of the interior region.

A discrimination between the extreme southern tract of the drift, in the Mississippi basin, and the more definite morainal belt of a later ice invasion was made by Prof. Chamberlin in 1882. A similar discrimination in Pennsylvania and New Jersey was made by R. D. Salisbury in 1891.

Against the great debt which American glaciology owes to European investigation there is something on the credit side. The skill acquired in the study of American moraines enabled two American geologists to find similar phenomena Europe. H. Carvill Lewis, in 1886, traced terminal moraines in Great Britain and Ireland, and one year later R. D. Salisbury did the same thing in Germany, these being the first discovery of open-country moraines of the massive order of the European ice sheets. These discoveries of European peripheral moraines were of great importance, as they laid the foundation for further location of morainal belts and so made possible a comparison of the marginal oscillations of the ice sheets of the two continents, by help of which the geologic equivalency of the suc-

* Address before the Boston meeting American Association Advancement of Science, Section E.

cessive glacial and interglacial deposits of Europe and America has been determined.

A peculiarity of the American deposits is the peripheral moraines common to, and produced by, two opposing or adjacent ice lobes and termed "interlobate" by Prof. Chamberlin.

The correlation of moraines of recession with glacial lake shore lines will be noted below. In the study of the successive moraine belts between Cincinnati and Mackinac, F. B. Taylor has reached the conclusion that these moraines were produced by periodic oscillations of climate, so slow as to be referable only to some astronomical cause, probably the precession of the equinoxes. But Croll's hypothesis is not believed to furnish alone a satisfactory explanation.

As regards the precise manner of morainal accumulation, especially of the taller hills, there is not entire concordance of opinion. In several writings Mr. Upham has argued that the moraines were formed from englacial drift during episodes of equality of advance and melting, following stages of greater ablation and concentration of superglacial drift; and that these conditions were possible only during the warm Champlain epoch. Other writers deny the existence of any large amount of englacial drift, except near the base, and regard even the highest moraine hills as due to piling of subglacial or basal drift by the thinner ice edge overriding its own débris.

Eskers.—The name "osar," borrowed from European literature, was applied by Edward Hitchcock to masses of water-laid drifts as early as 1842, and appears frequently in subsequent writings upon the drift. The word was generally used without close discrimination, however, being applied to irregular mounds of gravel and sand as well as to ridges. An early identification was made by C. T. Jackson, in 1843, who said that the European osars were identical with the "horse-backs" of Maine. During subsequent years, down to 1880, the word "kame" was generally employed instead of osar. The name "serpent kame" was applied by Shaler, in 1888, in print.

The term "esker" was first used by G. H. Kinahan in 1863, being applied to gravel ridges in Ireland, but in America it remained for W. J. McGee to make, in 1881, the needed differentiation between eskers, applied to elongated ridges of gravel and sand, and kames, designating sand or gravel deposits of irregular or morainic topography. Gradually the word esker has displaced the less convenient word osar, although the latter has priority.

Since the acceptance of the glacial theory it has generally been recognized that these ridges of gravel, under whatever name, were formed by glacial streams. In 1872, N. H. Winchell attributed the gravel ridges observed by him in Ohio and Minnesota to the work of streams in longitudinal crevasses, and a more definite explanation in America was made by Warren Upham, in 1876, when he referred those in New Hampshire to glacial rivers, either superglacial or subglacial.

The genetic distinction between eskers and kames, made by McGee in 1881, was emphasized and amplified by Chamberlin in 1883 and 1884, referring the esker phenomena (using the term osar) to the class of axiradiant or longitudinal stream drift, as distinguished from the peripheral kame deposits. That eskers are constructive forms, deposited in the beds of glacial streams, in comparatively stagnant ice, seems to be universally admitted. There remains, however, some lack of unanimity as to the attitude of the streams, whether upon or within or beneath the ice body. In 1884 Prof. Shaler gave reasons for believing them to be formed in channels of subglacial streams. Mr. Upham has regarded the streams as superglacial after the subglacial channels had become obstructed, or in some cases as flowing in deep ice-walled canyons, reaching perhaps to the ground. Down to 1890 George H. Stone, in his writings upon the drift phenomena of Maine, regarded the esker streams as mainly superglacial, but in 1893 he thought them subglacial, at least in the coastal region. In a critical study of the origin of certain eskers in Massachusetts by W. M. Davis, and in a discussion of the mechanics of the phenomena by J. B. Woodworth, both authors conclude that the streams were subglacial; and the weight of opinion now favors subglacial streams in the relatively stagnant submarginal portions of the ice sheet. The observations of Prof. Russell, in Alaska, and of Prof. Chamberlin upon the ice foot in Greenland, give force to this view. There seems to be no better explanation for the greatly extended, continuous eskers of uniform cross section or prism which traverse hills and valleys, than that they were formed in tunnels in or beneath the ice; the streams in many cases being under hydraulic pressure. But doubtless some of the broader or shorter, discontinuous irregular ridges may have been deposited in other ways, near the ice front. A question of some importance in this connection is the relative amount of interglacial or superglacial drift. In an ice body with little débris above its base, only subglacial streams could acquire great burden.

In northeastern Iowa occur some unique deposits which may be regarded as allies to eskers. They have been described by McGee and named "paha." These are elongated ridges of aqueo-glacial material upon the surface, deposited in canyons in the ice. "The streams were originally superglacial, so that the modern drainage is 'superimposed from ice,' to use Gilbert's expression; these streams were originally located by eminences under the ice, which retarded the flow and developed incipient lobation; and after the streams had deepened their channels so far as to materially reduce the thickness of the ice, then the subglacial water was forced toward the same lines, and the superglacial and subglacial flow coincided and eventually formed ice canyons in which the paha were accumulated."

(To be continued.)

The duration of slate roofs is variously placed, but is usually given as sixty years. A resident of Bangor, Pa., informs a contemporary, however, that in 1868, when he was living in England, he assisted in removing the slate from the roof of a building of the Plymouth dockyards that was known to have stood over three hundred years. After the old building had been torn down a new structure was erected on the same site, and the slates, after being redressed, were placed on the new roof, and at last accounts were still there. —Philadelphia Record.

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